## SCOPE OF WORK

TO INSTALL A RESIDENTIAL ROOFTOP SOLAR PHOTOVOLTAIC (PV) SYSTEM AND BATTERY BACKUP. THE POWER GENERATED BY THE PV SYSTEM WILL BE INTERCONNECTED WITH THE UTILITY GRID THROUGH THE EXISTING ELECTRICAL SERVICE EQUIPMENT. THE PV SYSTEM DOES INCLUDE BATTERIES.

## ELECTRICAL NOTES

1) ALL EQUIPMENT TO BE LISTED BY THE UL OR OTHER NRTL AND LABELED FOR ITS APPLICATION.
2) ALL CONDUCTORS SHALL BE COPPER, RATED FOR 600V AND 90°C WET ENVIRONMENT.
3) WIRING, CONDUIT, AND RACEWAYS MOUNTED ON ROOFTOPS SHALL BE ROUTED DIRECTLY TO, AND LOCATED AS CLOSE AS POSSIBLE TO THE NEAREST RIDGE, HIP, OR VALLEY.
4) WORKING CLEARANCES AROUND ALL NEW AND EXISTING ELECTRICAL EQUIPMENT SHALL COMPLY WITH NEC 110.26.
5) DRAWINGS INDICATE THE GENERAL ARRANGEMENT OF SYSTEMS. CONTRACTOR SHALL FURNISH ALL NECESSARY OUTLETS, SUPPORTS, FITTINGS AND ACCESSORIES TO FULFILL APPLICABLE CODES AND STANDARDS.
6) WHERE SIZES OF JUNCTION BOXES, RACEWAYS, AND CONDUITS ARE NOT SPECIFIED, THE CONTRACTOR SHALL SIZE THEM ACCORDINGLY.
7) ALL WIRE TERMINATIONS SHALL BE APPROPRIATELY LABELED AND READILY VISIBLE.
8) MODULE GROUNDING CLIPS TO BE INSTALLED BETWEEN MODULE FRAME AND MODULE SUPPORT RAIL, PER THE GROUNDING CLIP MANUFACTURER'S INSTRUCTION.
9) MODULE SUPPORT RAIL TO BE BONDED TO CONTINUOUS COPPER G.E.C. VIA WEEB LUG OR THE ILSCO GBL-4DBT LAY-IN LUG.
10) THE POLARITY OF THE GROUNDED CONDUCTORS IS (positive/negative) OR THE DC SIDE OF THE PV SYSTEM IS UNGROUNDED AND SHALL COMPLY WITH NEC 690.35

## NCDOI REQUIREMENTS

***OPTION 2***

WEIGHT OF PV SYSTEM ON ROOF:

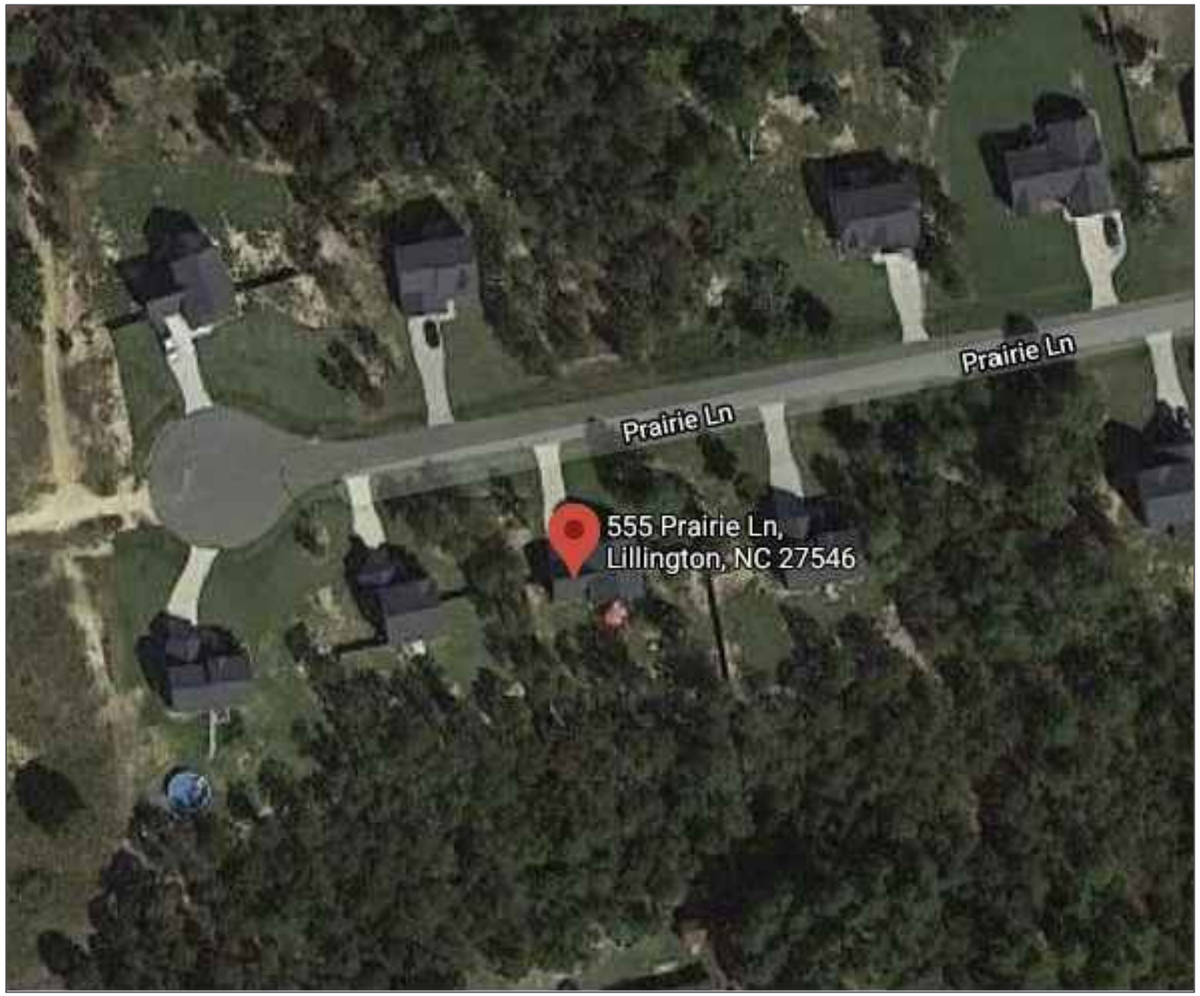
**2.6483 PSF**

EXISTING ROOF MATERIAL TYPE:

**ASPHALT SHINGLE (SINGLE LAYER)**

PROJECT LOCATION WIND ZONE:

**115 MPH**




## VICINITY MAP

NOTICE TO CONTRACTOR
All construction must comply with current NC Building Codes and is subject to field inspection and verification.
APPROVED
Limited building only review
Permit holder responsible for full compliance with the code
03/15/2021
Harnett COUNTY NORTH CAROLINA

| SHEET INDEX | |
|---|---|
| COVER | GENERAL INFORMATION |
| PV-1 | SITE PLAN |
| PV-2 | ROOF LAYOUT AND MOUNTING DETAIL |
| PV-3 | ELECTRICAL SCHEMATIC |
| PV-4 | AMPACITY CALCULATIONS AND WIRE SIZING |
| PV-5 | LABELING SCHEDULE |
| CUTSHEETS | MANUFACTURER SPECIFICATION SHEETS |

| GOVERNING CODES |
|---|
| NFPA 70 NATIONAL ELECTRICAL CODE 2017 |
| 2018 INTERNATIONAL BUILDING CODE |
| 2018 NORTH CAROLINA BUILDING CODE |
| 2018 NORTH CAROLINA RESIDENTIAL CODE |
| UNDERWRITERS LABORATORIES (UL) STANDARDS |
| OSHA 29 CFR 1910.269 |
| NORTH CAROLINA DEPARTMENT OF INSURANCE |

| DESIGN SPECIFICATIONS | |
|---|---|
| CONSTRUCTION TYPE | SINGLE-FAMILY |
| ZONING | RESIDENTIAL |
| GROUND SNOW LOAD | 20 PSF |
| WIND EXPOSURE CATEGORY | CATEGORY B |
| WIND SPEED | 115 MPH |
| UTILITY PROVIDER | DUKE PROGRESS |
| AHJ | TOWN OF LILLINGTON (HARNETT COUNTY) |

| SYSTEM SPECIFICATIONS | |
|---|---|
| SOLAR MODULES | (34) HANWHA Q.PEAK DUO BLK-G6+ 340 |
| POWER OPTIMIZERS | (34) SOLAREDGE P340 |
| INVERTER(S) | (1) SOLAREDGE SE10000H-US |
| SOLAR MOUNTS | SNAPNRACK COMP MOUNT |
| SOLAR RACKING SYSTEM | SNAPNRACK ULTRA RAIL 40 |
| MONITORING | YES |
| POINT OF INTERCONNECT | 60A/2P LOAD SIDE BREAKER IN TESLA GATEWAY |

**CONTRACTOR**


Covenant Solar Tech
**DBA SUN DOLLAR ENERGY**
3200 WELLINGTON COURT SUITE 101
RALEIGH, NC 27615
(919) 508-6907
NC ELE LICENSE #: 30043U
NC GC LICENSE #: 84770


**PROJECT & CLIENT INFORMATION**

**BERRY RESIDENCE**
**SOLAR PV + STORAGE SYSTEM**
SYSTEM SIZE: 11.56 KW DC
SYSTEM SIZE: 10.0 KW AC

**GUY BERRY**
555 PRAIRIE LN
LILLINGTON, NC 27546
(443) 995-7100

**ENGINEER OF RECORD**

**DRAWING BY**

CST

**REVISIONS**

| DESCRIPTION | DATE | # | BY |
|---|---|---|---|
| RELEASED FOR PERMITTING | 3/9/2021 | 1 | CST |
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**SHEET SIZE**

ANSI B
11" X 17"

**DATE**

3/9/2021

**SHEET NAME**

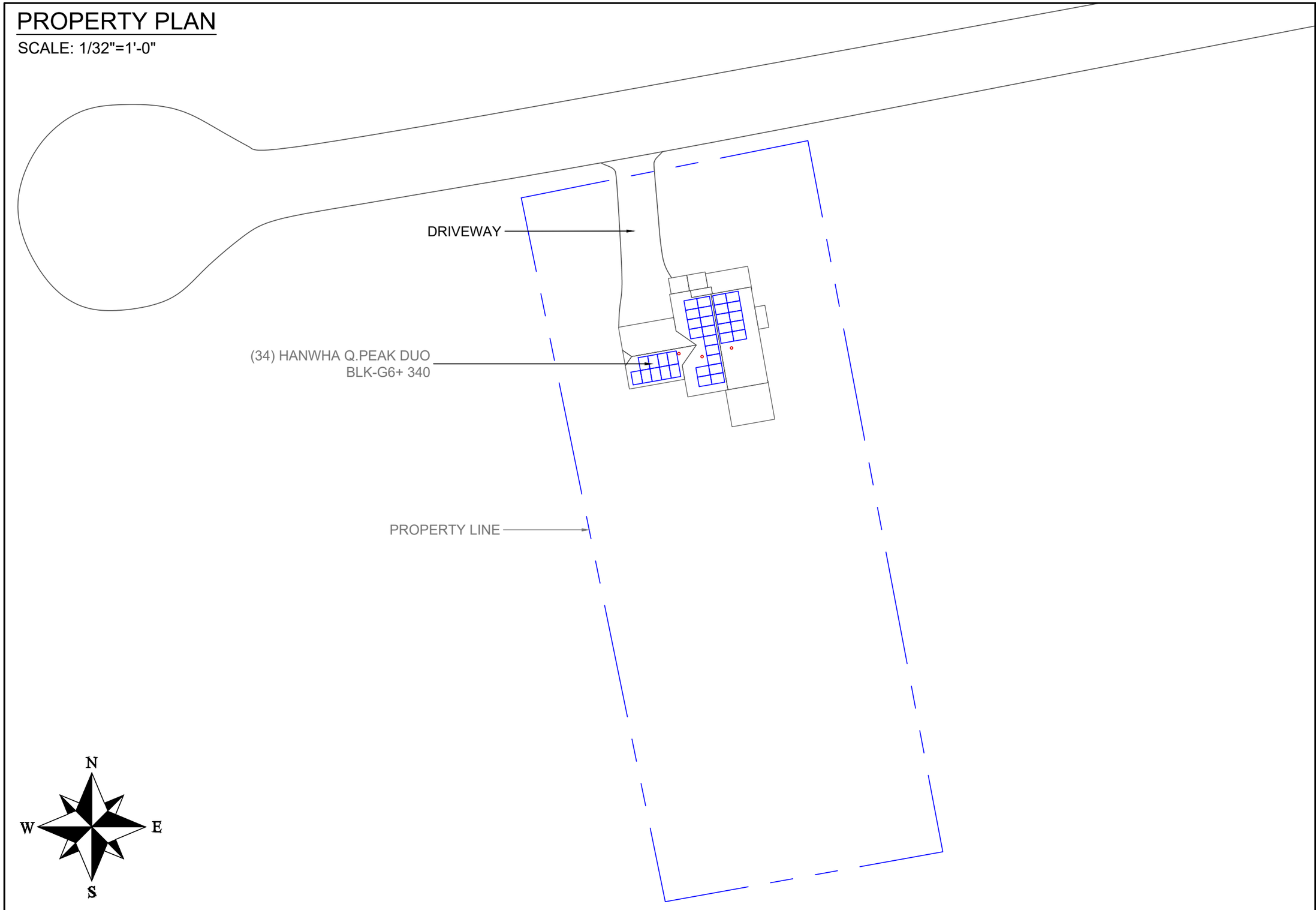
GENERAL INFORMATION

**SHEET NUMBER**

COVER

# PROPERTY PLAN

SCALE: 1/32"=1'-0"





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**SHEET SIZE**

ANSI B
11" X 17"

**DATE**

3/9/2021

**SHEET NAME**

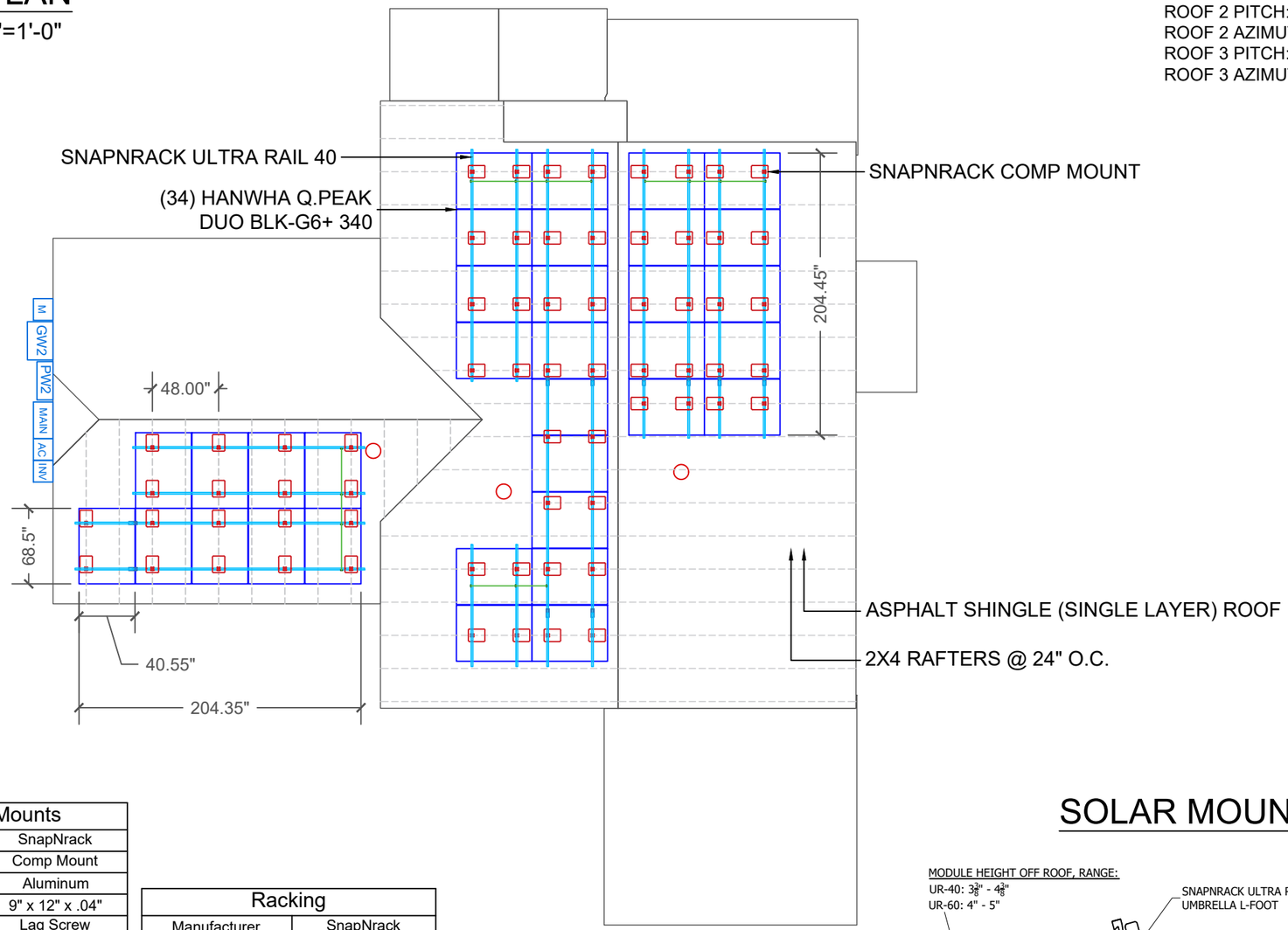
SITE PLAN

**SHEET NUMBER**

PV-1

# ROOF PLAN

SCALE: 1/8"=1'-0"




ROOF 1 PITCH: 34°
ROOF 1 AZIMUTH: 170°
ROOF 2 PITCH: 34°
ROOF 2 AZIMUTH: 260°
ROOF 3 PITCH: 34°
ROOF 3 AZIMUTH: 80°

| LOAD CALCULATIONS | | |
|---|---|---|
| NUMBER OF MODULES | 34 | |
| MODULE WEIGHT | 43.9 | LBS |
| MODULE SQ FT | 19.313 | SQ FT |
| TOTAL MODULE WEIGHT | 1492.6 | LBS |
| TOTAL MODULE SQ FT | 656.642 | SQ FT |
| NUMBER OF PORTRAIT | 34 | |
| NUMBER OF LANDSCAPE | 0 | |
| NUMBER OF OPTIMIZERS | 34 | |
| WEIGHT PER OPTIMIZER | 1.5 | LBS |
| TOTAL OPTIMIZER WEIGHT | 51 | LBS |
| TOTAL LENGTH OF RAIL | 227 | LF |
| RAIL WEIGHT PER FOOT | 0.56 | LBS |
| TOTAL RAIL WEIGHT | 127.12 | LBS |
| NUMBER OF FLANGES | 66 | |
| WEIGHT PER FLANGE | 0.7565 | LBS |
| WEIGHT PER SYSTEM | 49.929 | LBS |
| NUMBER OF MID CLAMPS | 54 | |
| MID CLAMP WEIGHT | 0.21 | LBS |
| WEIGHT PER SYSTEM | 11.34 | LBS |
| NUMBER OF END CLAMPS | 28 | |
| END CLAMP WEIGHT | 0.32 | LBS |
| WEIGHT PER SYSTEM | 6 | LBS |
| NUMBER OF SPLICES | 10 | |
| WEIGHT PER SPLICE | 0.1 | LBS |
| WEIGHT PER SYSTEM | 1 | LBS |
| TOTAL ARRAY WEIGHT | 1738.989 | LBS |
| POINT LOAD | 26.348318 | LBS/FT |
| TOTAL ARRAY AREA | 656.642 | SQ FT |
| **ARRAY DEAD LOAD** | **2.6483** | **PSF** |

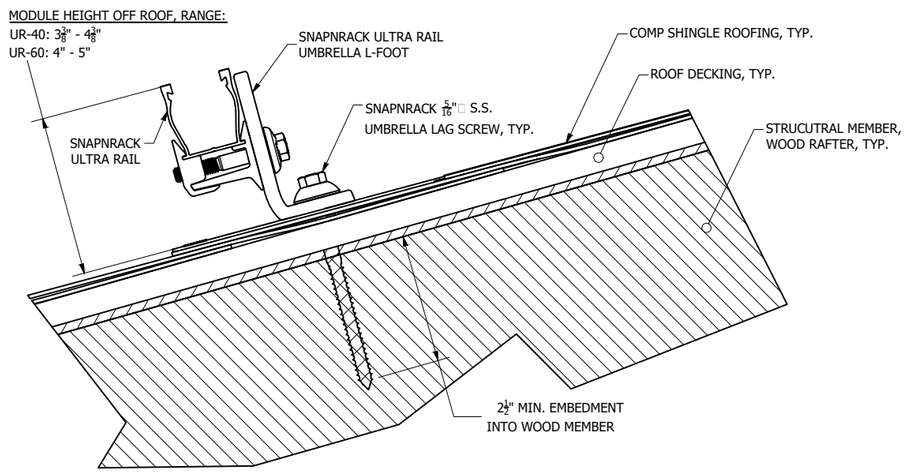
| Flashings/Mounts | |
|---|---|
| Manufacturer | SnapNrack |
| Mount Type | Comp Mount |
| Flashing Material | Aluminum |
| Flashing Size | 9" x 12" x .04" |
| Fastener Type | Lag Screw |
| Fastener Material | 18-8 Stainless Steel |
| Fastener Size | 5/16" x 4" |
| L-Foot Material | Aluminum |
| Sealing Washer | EPDM Bonded SS |
| Sealing Washer Size | 5/16" ID x 3/4" OD |
| Weight | 0.7565 Lbs. |
| Structural | IBC Compliant |
| UL Listing | UL 2703 |

| Racking | |
|---|---|
| Manufacturer | SnapNrack |
| Model Number | Ultra Rail 40 |
| Length | 168" |
| Width | 1.54" |
| Height | 1.89" |
| Weight | 0.56 Lbs./Ft |
| Material | Aluminum |
| Structural | IBC Compliant |
| UL Listing | UL 2703 |

## LEGEND

- M UTILITY METER
- MSP MAIN SERVICE PANEL
- INV INVERTER
- AC AC DISCONNECT
- DC DC DISCONNECT
- JB JUNCTION BOX
- SUB SUBPANEL
- LC LOAD CENTER
- (M) PV METER
- EXTERIOR CONDUIT
- G GAS METER
- FLASHINGS
- RAILS
- GROUNDING
- RAIL SPLICE

## SOLAR MOUNTING DETAIL





CONTRACTOR

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NC GC LICENSE #: 84770


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SYSTEM SIZE: 10.0 KW AC

**GUY BERRY**
555 PRAIRIE LN
LILLINGTON, NC 27546
(443) 995-7100

ENGINEER OF RECORD

DRAWING BY

CST

REVISIONS

| DESCRIPTION | DATE | # | BY |
|---|---|---|---|
| RELEASED FOR PERMITTING | 3/9/2021 | 1 | CST |
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SHEET SIZE

ANSI B
11" X 17"

DATE

3/9/2021

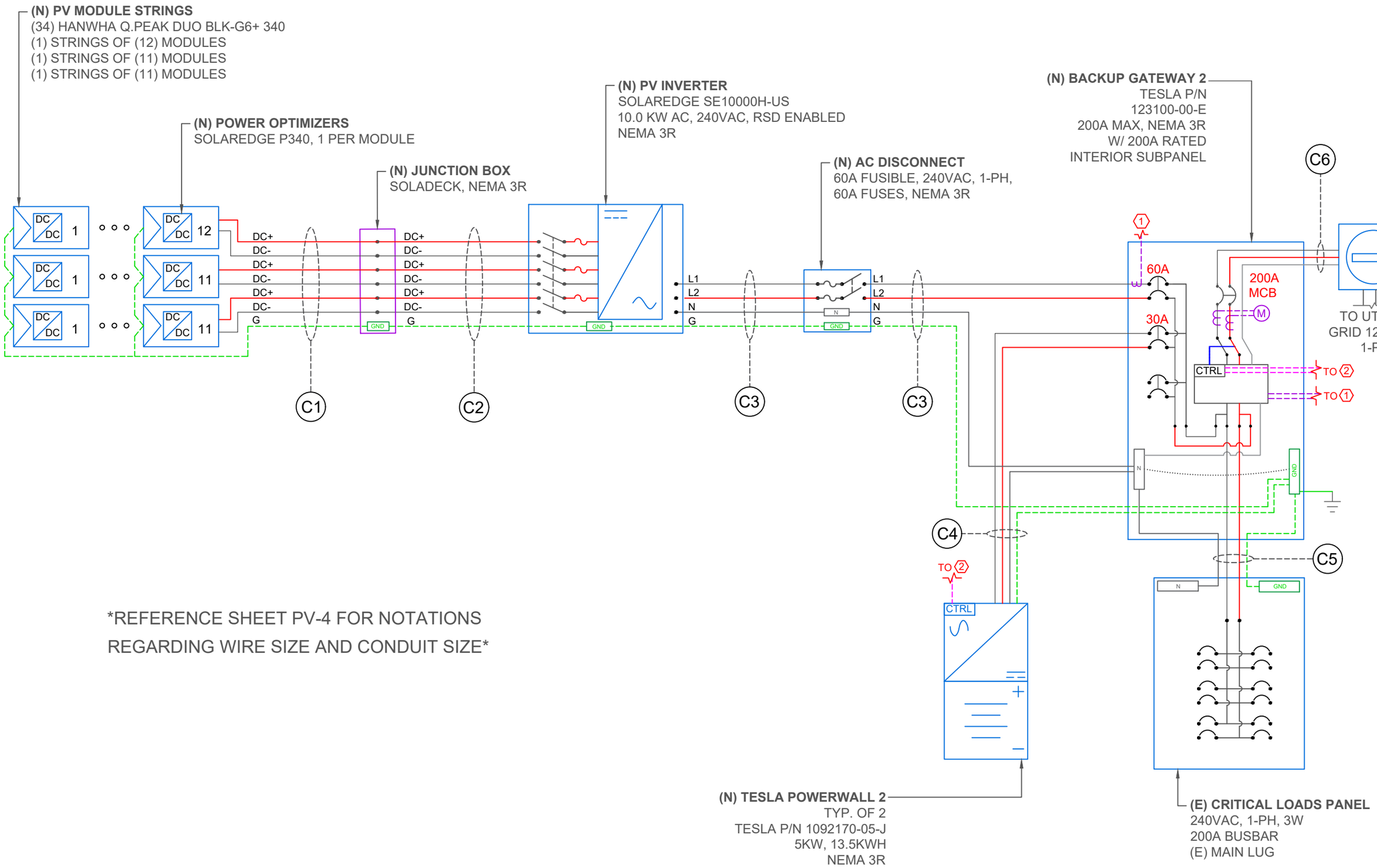
SHEET NAME

ROOF LAYOUT & DETAIL DRAWINGS

SHEET NUMBER

PV-2

# ELECTRICAL LINE DIAGRAM




*REFERENCE SHEET PV-4 FOR NOTATIONS
REGARDING WIRE SIZE AND CONDUIT SIZE*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SHEET SIZE

ANSI B
11" X 17"

DATE

3/9/2021

SHEET NAME

ELECTRICAL SCHEMATIC

SHEET NUMBER

PV-3

## Solar PV Module Data

| | |
|---|---|
| Manufacturer | Hanwha |
| Model Number | Q-Peak DUO BLK-G6+ |
| Max Power (Pmax) | 340 |
| Max Power Voltage (Vmp) | 33.94 |
| Max Power Current (Imp) | 10.02 |
| Open Circuit Voltage (Voc) | 40.66 |
| Short Circuit Current (Isc) | 10.52 |
| Max Series Fuse (OCPD) | 20 |
| Max System Voltage | 1000 |
| UL Listing | UL1703 |
| Protection Rating | IP67 |

## Power Optimizer Data

| | |
|---|---|
| Manufacturer | SolarEdge |
| Model Number | P340 |
| Rated DC Input Power | 340 |
| Max Input Voltage | 48 |
| Max Input Current | 13.75 |
| Max Short Circuit Current | 11 |
| Max Output Voltage | 60 |
| Max Output Current | 15 |
| UL Listing | UL1741 |
| Protection Rating | IP68/NEMA6P |

## Junction Box Data

| | |
|---|---|
| Manufacturer | Soladeck |
| Model Number | 0799-5B |
| Voltage Rating | 600 |
| Amperage Rating | 120 |
| UL Listing | UL 50 |
| Enclosure Rating | NEMA 3R |

## Powerwall 2 (AC) Data (New)

| | |
|---|---|
| Manufacturer | Tesla |
| Model Type | Powerwall 2 |
| Model Number | 1092170-05-J |
| Voltage Rating | 120/240 Volts |
| Total Energy | 14 kWh |
| Usable Energy | 13.5 kWh |
| Max Continuous Power | 5 kW |
| Real Power (10s) | 7 kW |
| Apparent Power | 5.8 kW |
| Apparent Power (10s) | 7.2 kW |
| Max Output Current | 30 Amps |
| Phase | Single |
| UL Listing | UL1642, UL1741, UL1973, UL9540 |
| Enclosure Rating | NEMA 3R |

## Inverter Data

| | |
|---|---|
| Manufacturer | SolarEdge |
| Model Number | SE10000H-US |
| Max DC Input Voltage | 480 |
| Nominal DC Input Voltage | 400 |
| Max DC Input Current | 27 |
| Max DC Short Circuit Current | 45 |
| Max DC Input Power | 15500 |
| Max AC Output Power | 10000 |
| Nominal AC Output Voltage | 240 |
| Max AC Output Current | 42 |
| Strings Per Inverter | 1 - 3 |
| UL Listing | UL1741 |
| Enclosure Rating | NEMA 4X |

## AC Disconnect Data

| | |
|---|---|
| Manufacturer | Eaton |
| Model Number | DG222NRB |
| Voltage Rating | 240 |
| Amperage Rating | 60 |
| Phase | Single |
| Switch Syle | Fusible |
| Fuse Rating | 60 |
| UL Listing | UL 98 |
| Enclosure Rating | NEMA 3R |

## Critical Loads Panel Data

| | |
|---|---|
| Manufacturer | Eaton |
| Model Type | N/A |
| Model Number | MB1212L200BTS |
| Voltage Rating | 120/240 |
| Busbar Amp Rating | 200 |
| Main Breaker/Main Lug | Main Lug |
| Breaker Amp Rating | N/A |
| Phase | Single |
| UL Listing | UL 6294 |
| Enclosure Rating | NEMA 3R |

## Backup Gateway 2 Data (New)

| | |
|---|---|
| Manufacturer | Tesla |
| Model Type | Backup Gateway 2 |
| Model Number | 123100-00-E |
| Voltage Rating | 120/240 Volts |
| Busbar Amperage Rating | 200A |
| Main Breaker or Main Lug | Main Breaker |
| Breaker Rating | 200A |
| Phase | Single |
| UL Listing | UL67, UL869A, UL916, UL1741 |
| Enclosure Rating | NEMA 3R |

## Temperature Data

| | |
|---|---|
| Average High Temp | 93.2˚ F |
| Record Low Temp | 10.4˚ F |

# WIRE SCHEDULE

| TAG | CURRENT CARRYING CONDUCTORS | | | | GROUNDING CONDUCTORS | | | | CONDUIT/RACEWAY | | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | QTY. | SIZE | MATERIAL | INSULATION TYP. | QTY. | SIZE | MATERIAL | INSULATION TYP. | QTY. | SIZE | MATERIAL | LOCATION | |
| C1 | 6 | 10 AWG | COPPER | PV WIRE | 1 | 8 AWG | BARE COPPER | N/A | - | - | - | FREE AIR | |
| C2 | 6 | 10 AWG | COPPER | THHN/THWN-2 | 1 | 10 AWG | COPPER | THHN/THWN-2 | 1 | 3/4" | LFMC/EMT | EXTERIOR/INTERIOR | |
| C3 | 3 | 6 AWG | COPPER | THHN/THWN-2 | 1 | 10 AWG | COPPER | THHN/THWN-2 | 1 | 3/4" | LFNC/EMT | EXTERIOR | |
| C4 | 3 | 10 AWG | COPPER | THHN/THWN-2 | 1 | 10 AWG | COPPER | THHN/THWN-2 | 1 | 3/4" | LFNC/EMT | EXTERIOR | |
| C5 | 3 | 4/0 AWG | ALUMINUM | XHHW-2 | 1 | 2 AWG | ALUMINUM | XHHW-2 | 1 | 2" | PVC | EXTERIOR | |
| C6 | 3 | 4/0 AWG | ALUMINUM | XHHW-2 | - | - | - | - | 1 | 2" | PVC | EXTERIOR | |

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SYSTEM SIZE: 10.0 KW AC

**GUY BERRY**
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LILLINGTON, NC 27546
(443) 995-7100

ENGINEER OF RECORD

DRAWING BY

CST

REVISIONS

| DESCRIPTION | DATE | # | BY |
|---|---|---|---|
| RELEASED FOR PERMITTING | 3/9/2021 | 1 | CST |

SHEET SIZE

ANSI B
11" X 17"

DATE

3/9/2021

SHEET NAME

ELECTRICAL DATA
WIRE SCHEDULE

SHEET NUMBER

PV-4

# Ampacity Calculations

Wiring Location: Module to Power Optimizer (Direct Current)
Wiring Location: Inverter to Service Entrance (Alternating Current)
All calculations show minimum sizing for ampacity
Actual wire sizing may be larger for voltage drop or other factors
All calculations are according to the 2017 National Electric Code

**Modules: Hanwha Q-Peak DUO BLK-G6+ 340**
**Inverter: SolarEdge SE10000H-US**

**Initial Input Values**

| | | | | | | |
|---|---|---|---|---|---|---|
| Isc (Short Circuit Current) | 10.52 | | | | | |
| Number of circuits | 10.52 | x | 1 | = | 10.52 | |
| Maximum Circuit Current (NEC 690.8 (A)(1+2) | 10.52 | x | 156% | = | 16.4112 | |
| Minimum Overcurrent Device | 20 | A | Series Fuse Rating by Manufacturer | | | |
| | **Size AWG #** | | | | | |
| Chosen Conductor Type (THHN, RHW-2, or USE-2) | 10 | | | | | |

**Conductor Derating**

| | | | | | | |
|---|---|---|---|---|---|---|
| NEC 690.31 © ref (NEC 310.16) | | | | | | |
| Conductor 90°C Ampacity | | 40 | | | | |
| Conduit Fill Derating | 1-3 | 40 | x | 1 | = | 40 |
| Temperature Derating (°F) | 141-149 | 40 | x | 0.65 | = | 26 |

**Ampacity vs Overcurrent Device**

| | | | |
|---|---|---|---|
| Conductor Ampacity Check | 26 | 16.4112 | OK |
| Conductor to Overcurrent Check | 26 | 20 | OK |

Input Data Into Yellow Fields
Green Field must say OK

Use this calculation for over current protection and wire sizing for stringers coming from Solar Panels.
Isc comes from manufacturer

# Ampacity Calculations

Wiring Location: Inverter to Service Entrance (Alternating Current)
All calculations show minimum sizing for ampacity
Actual wire sizing may be larger for voltage drop or other factors
All calculations are according to the 2017 National Electric Code

**Modules: Hanwha Q-Peak DUO BLK-G6+ 340**
**Inverter: SolarEdge SE10000H-US**

**Initial Input Values**

| | | | | | | |
|---|---|---|---|---|---|---|
| Inverter Continuous AC Output Combined (Watts) | 10000 | | | | | |
| Minimum Operating Voltage | 240 | | | | | |
| | | Watts | | Volts | | Amps |
| | | 10000 | / | 240 | = | 42 |
| Inverter Continuous AC Amps | | 42 | | | | |
| Number of Inverters | | 42 | x | 1 | = | 42 |
| **Overcurrent Device Rating** | | | | | | |
| **NEC 690.8 (B)(3)** | | 42 | x | 125% | = | 52.5 |
| Minimum Overcurrent Device | | 60 | Amps | | | |
| Circuit Breaker Size per NEC 240.6(A) | | 60 | Amps | | | |
| | | Size AWG # | | | | |
| Chosen Conductor Type THHN,THWN,RHW-2 or USE-2 | | 6 | | | | |

**Conductor Derating**

| | | | | | | |
|---|---|---|---|---|---|---|
| NEC 690.31© ref (NEC 310.16) | | | | | | |
| Conductor 90°C Ampacity | | 75 | | | | |
| Conduit Fill Derating | 1-3 | 75 | x | 1 | = | 75 |
| Temperature Derating (°F) | 105-113 | 75 | x | 0.87 | = | 65.25 |

**Ampacity vs Overcurrent Device**

| | | | |
|---|---|---|---|
| Conductor Ampacity Check | 65.25 | 52.5 | OK |
| Conductor to Overcurrent Check | 65.25 | 60 | OK |

Input Data into Yellow Fields
Green Fields must say OK

Use this calculation for over current protection and wire sizing for inverter


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ENGINEER OF RECORD

DRAWING BY
CST

REVISIONS

| DESCRIPTION | DATE | # | BY |
|---|---|---|---|
| RELEASED FOR PERMITTING | 3/9/2021 | 1 | CST |

SHEET SIZE
ANSI B
11" X 17"

DATE
3/9/2021

SHEET NAME
AMPACITY CALCULATIONS

SHEET NUMBER
PV-5

# PV LABELS

SIGNAGE REQUIREMENTS

> WARNING SIGNS OR LABELS SHALL COMPLY WITH NEC 110.21(B)
> MIN. 3/8" LETTER HEIGHT
> ALL CAPITAL LETTERS
> ARIAL OR SIMILAR FONT
> REFLECTIVE, WEATHER RESISTANT MATERIAL, UL 969

PHOTOVOLTAIC SYSTEM
⚠ DC DISCONNECT ⚠

| | |
|---|---|
| RATED MMP CURRENT | AMPS |
| RATED MPP VOLTAGE | VOLTS |
| MAX SYSTEM VOLTAGE | VDC |
| MAX CIRCUIT CURRENT | AMPS |

NEC 690.53 — 1

APPLY TO:
INVERTER

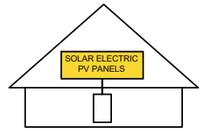
WARNING: PHOTOVOLTAIC POWER SOURCE

NEC 690.31(G)(3)(4) — 2

APPLY TO:
SOLAR DC RACEWAYS
DC JUNCTION BOXES

**SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN**

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




NEC 690.56(C)(1)(a) — 3

APPLY TO:
MAIN SERVICE DISCONNECT

⚠ WARNING

ELECTRIC SHOCK HAZARD

TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

NEC 690.13(B) — 4

APPLY TO:
DISCONNECTS
SOLAR LOAD CENTERS
COMBINER BOXES

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

NEC 690.56(C)(3) — 5

APPLY TO:
INVERTERS

PHOTOVOLTAIC SYSTEM
⚠ AC DISCONNECT ⚠

| | |
|---|---|
| OPERATING VOLTAGE | VAC |
| OPERATING CURRENT | AMPS |

NEC 690.54 — 6

APPLY TO:
AC DISCONNECT

⚠ WARNING

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

NEC 705.12 (B)(2)(3)(c) — 7

APPLY TO:
SERVICE PANEL(S)

⚠ WARNING

THE DISCONNECTION OF THE GROUNDED CONDUCTOR(S) MAY RESULT IN OVERVOLTAGE ON THE EQUIPMENT

NEC 690.31 (I) — 8

APPLY TO:
INVERTER(S)

SOLAR PV BREAKER

BREAKER IS BACKFED
DO NOT RELOCATE

NEC 705.12(B)(2)(3)(b) — 9

APPLY TO:
PV SYSTEM BREAKER

MAIN PV SYSTEM DISCONNECT

NEC 690.13 (B) — 10

APPLY TO:
MAIN AC DISCONNECT

BATTERY DISCONNECT

NEC 706.7 — 11

APPLY TO:
BATTERY DISCONNECT

CONTRACTOR

Covenant Solar Tech
DBA SUN DOLLAR ENERGY
3200 WELLINGTON COURT SUITE 101
RALEIGH, NC 27615
(919) 508-6907
NC ELE LICENSE #: 30043U
NC GC LICENSE #: 84770

PROJECT & CLIENT INFORMATION

**BERRY RESIDENCE**
**SOLAR PV + STORAGE SYSTEM**
SYSTEM SIZE: 11.56 KW DC
SYSTEM SIZE: 10.0 KW AC

**GUY BERRY**
555 PRAIRIE LN
LILLINGTON, NC 27546
(443) 995-7100

ENGINEER OF RECORD

DRAWING BY

CST

REVISIONS

| DESCRIPTION | DATE | # | BY |
|---|---|---|---|
| RELEASED FOR PERMITTING | 3/9/2021 | 1 | CST |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

SHEET SIZE

ANSI B
11" X 17"

DATE

3/9/2021

SHEET NAME

LABELING SCHEDULE

SHEET NUMBER

PV-6

powered by Q.ANTUM DUO

# Q.PEAK DUO BLK-G6+

## 330-345

ENDURING HIGH PERFORMANCE

VDE 11/2016 Quality Tested – high reliability, low degradation, optimized durability, continous line monitoring – www.VDEinfo.com ID. 40032587

EUPD RESEARCH TOP BRAND PV MODULES EUROPE 2019

Q CELLS YIELD SECURITY – ANTI PID TECHNOLOGY (APT); HOT-SPOT PROTECT (HSP); TRACEABLE QUALITY (TRA.Q™); ANTI LID TECHNOLOGY (ALT)

### Q.ANTUM TECHNOLOGY: LOW LEVELIZED COST OF ELECTRICITY

Higher yield per surface area, lower BOS costs, higher power classes, and an efficiency rate of up to 19.5 %.

### INNOVATIVE ALL-WEATHER TECHNOLOGY

Optimal yields, whatever the weather with excellent low-light and temperature behavior.

### ENDURING HIGH PERFORMANCE

Long-term yield security with Anti LID and Anti PID Technology[1], Hot-Spot Protect and Traceable Quality Tra.Q™.

### EXTREME WEATHER RATING

High-tech aluminum alloy frame, certified for high snow (5400 Pa) and wind loads (4000 Pa).

### A RELIABLE INVESTMENT

Inclusive 25-year product warranty and 25-year linear performance warranty[2].

### STATE OF THE ART MODULE TECHNOLOGY

Q.ANTUM DUO combines cutting edge cell separation and innovative wiring with Q.ANTUM Technology.

[1] APT test conditions according to IEC/TS 62804-1:2015, method B (–1500 V, 168 h)
[2] See data sheet on rear for further information

### THE IDEAL SOLUTION FOR:

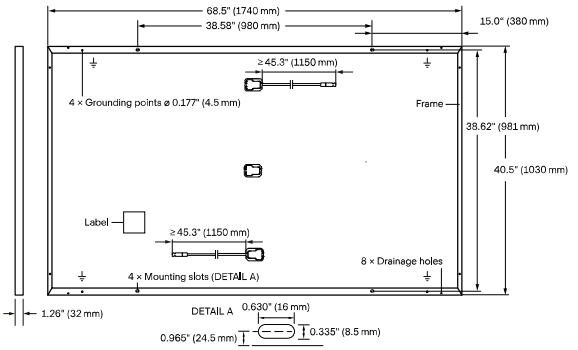
Rooftop arrays on residential buildings

Engineered in Germany

Q CELLS

## MECHANICAL SPECIFICATION

| | |
|---|---|
| Format | 68.5 × 40.6 × 1.26 in (including frame)<br>(1740 × 1030 × 32 mm) |
| Weight | 43.9 lbs (19.9 kg) |
| Front Cover | 0.13 in (3.2 mm) thermally pre-stressed glass<br>with anti-reflection technology |
| Back Cover | Composite film |
| Frame | Black anodized aluminum |
| Cell | 6 × 20 monocrystalline Q.ANTUM solar half cells |
| Junction Box | 2.09-3.98 × 1.26-2.36 × 0.59-0.71 in (53-101 × 32-60 ×<br>15-18 mm), Protection class IP67, with bypass diodes |
| Cable | 4 mm² Solar cable; (+) ≥45.3 in (1150 mm), (–) ≥45.3 in (1150 mm) |
| Connector | Stäubli MC4, Hanwha Q CELLS HQC4, Amphenol UTX,<br>Renhe 05-6, Tongling TL-Cable01S, JMTHY JM601; IP68 or<br>Friends PV2e; IP67 |

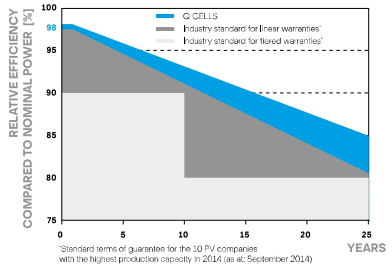



## ELECTRICAL CHARACTERISTICS

| POWER CLASS | | | | 330 | 335 | 340 | 345 |
|---|---|---|---|---|---|---|---|
| MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / –0 W) | | | | | | | |
| Minimum | Power at MPP[1] | $P_{MPP}$ | [W] | 330 | 335 | 340 | 345 |
| | Short Circuit Current[1] | $I_{SC}$ | [A] | 10.41 | 10.47 | 10.52 | 10.58 |
| | Open Circuit Voltage[1] | $V_{OC}$ | [V] | 40.15 | 40.41 | 40.66 | 40.92 |
| | Current at MPP | $I_{MPP}$ | [A] | 9.91 | 9.97 | 10.02 | 10.07 |
| | Voltage at MPP | $V_{MPP}$ | [V] | 33.29 | 33.62 | 33.94 | 34.25 |
| | Efficiency[1] | η | [%] | ≥18.4 | ≥18.7 | ≥19.0 | ≥19.3 |
| MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NMOT[2] | | | | | | | |
| Minimum | Power at MPP | $P_{MPP}$ | [W] | 247.0 | 250.7 | 254.5 | 258.2 |
| | Short Circuit Current | $I_{SC}$ | [A] | 8.39 | 8.43 | 8.48 | 8.52 |
| | Open Circuit Voltage | $V_{OC}$ | [V] | 37.86 | 38.10 | 38.34 | 38.59 |
| | Current at MPP | $I_{MPP}$ | [A] | 7.80 | 7.84 | 7.89 | 7.93 |
| | Voltage at MPP | $V_{MPP}$ | [V] | 31.66 | 31.97 | 32.27 | 32.57 |

[1]Measurement tolerances $P_{MPP}$ ±3%; $I_{SC}$; $V_{OC}$ ±5% at STC: 1000 W/m², 25±2 °C, AM 1.5 according to IEC 60904-3 • [2]800 W/m², NMOT, spectrum AM 1.5

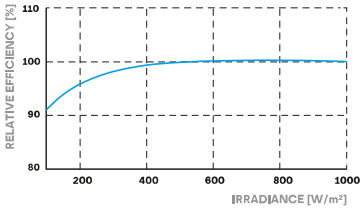
### Q CELLS PERFORMANCE WARRANTY




At least 98 % of nominal power during first year. Thereafter max. 0.54 % degradation per year. At least 93.1 % of nominal power up to 10 years. At least 85 % of nominal power up to 25 years.

All data within measurement tolerances. Full warranties in accordance with the warranty terms of the Q CELLS sales organization of your respective country.

### PERFORMANCE AT LOW IRRADIANCE




Typical module performance under low irradiance conditions in comparison to STC conditions (25 °C, 1000 W/m²)

| TEMPERATURE COEFFICIENTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Temperature Coefficient of $I_{SC}$ | α | [%/K] | +0.04 | Temperature Coefficient of $V_{OC}$ | β | [%/K] | –0.27 |
| Temperature Coefficient of $P_{MPP}$ | γ | [%/K] | –0.36 | Normal Module Operating Temperature | NMOT | [°F] | 109±5.4 (43±3 °C) |

## PROPERTIES FOR SYSTEM DESIGN

| | | | | |
|---|---|---|---|---|
| Maximum System Voltage $V_{SYS}$ | [V] | 1000 (IEC) / 1000 (UL) | Safety Class | II |
| Maximum Series Fuse Rating | [A DC] | 20 | Fire Rating based on ANSI / UL 1703 | C (IEC) / TYPE 2 (UL) |
| Max. Design Load, Push / Pull[3] | [lbs / ft²] | 75 (3600 Pa) / 55 (2667 Pa) | Permitted Module Temperature<br>on Continuous Duty | –40 °F up to +185 °F<br>(–40 °C up to +85 °C) |
| Max. Test Load, Push / Pull[3] | [lbs / ft²] | 113 (5400 Pa) / 84 (4000 Pa) | | |

[3] See Installation Manual

## QUALIFICATIONS AND CERTIFICATES

UL 1703, VDE Quality Tested, CE-compliant, IEC 61215:2016, IEC 61730:2016, Application Class II, U.S. Patent No. 9,893,215 (solar cells)

## PACKAGING INFORMATION

| | |
|---|---|
| Number of Modules per Pallet | 32 |
| Number of Pallets per 53' Trailer | 28 |
| Number of Pallets per 40' HC-Container | 24 |
| Pallet Dimensions (L × W × H) | 71.5 × 45.3 × 48.0 in (1815 × 1150 × 1220 mm) |
| Pallet Weight | 1505 lbs (683 kg) |

**Note:** Installation instructions must be followed. See the installation and operating manual or contact our technical service department for further information on approved installation and use of this product.

**Hanwha Q CELLS America Inc.**
400 Spectrum Center Drive, Suite 1400, Irvine, CA 92618, USA | **TEL** +1 949 748 59 96 | **EMAIL** inquiry@us.q-cells.com | **WEB** www.q-cells.us

INVERTERS

# Single Phase Inverter with HD-Wave Technology

## for North America

SE3000H-US / SE3800H-US / SE5000H-US / SE6000H-US /
SE7600H-US / SE10000H-US / SE11400H-US

12-25 YEAR WARRANTY


## Optimized installation with HD-Wave technology

- Specifically designed to work with power optimizers
- Record-breaking efficiency
- Quick and easy inverter commissioning directly from a smartphone using the SolarEdge SetApp
- Fixed voltage inverter for longer strings
- Integrated arc fault protection and rapid shutdown for NEC 2014 and 2017, per article 690.11 and 690.12
- UL1741 SA certified, for CPUC Rule 21 grid compliance
- Extremely small
- Built-in module-level monitoring
- Outdoor and indoor installation
- Optional: Revenue grade data, ANSI C12.20 Class 0.5 (0.5% accuracy)



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# Single Phase Inverter with HD-Wave Technology for North America

## SE3000H-US / SE3800H-US / SE5000H-US / SE6000H-US/ SE7600H-US / SE10000H-US / SE11400H-US

| Model Number | SE3000H-US | SE3800H-US | SE5000H-US | SE6000H-US | SE7600H-US | SE10000H-US | SE11400H-US | |
|---|---|---|---|---|---|---|---|---|
| APPLICABLE TO INVERTERS WITH PART NUMBER | SEXXXXH-XXXXXBXX4 | | | | | | | |
| **OUTPUT** | | | | | | | | |
| Rated AC Power Output | 3000 | 3800 @ 240V<br>3300 @ 208V | 5000 | 6000 @ 240V<br>5000 @ 208V | 7600 | 10000 | 11400 @ 240V<br>10000 @ 208V | VA |
| Maximum AC Power Output | 3000 | 3800 @ 240V<br>3300 @ 208V | 5000 | 6000 @ 240V<br>5000 @ 208V | 7600 | 10000 | 11400 @ 240V<br>10000 @ 208V | VA |
| AC Output Voltage Min.-Nom.-Max. (211 - 240 - 264) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Vac |
| AC Output Voltage Min.-Nom.-Max. (183 - 208 - 229) | - | ✓ | - | ✓ | - | - | ✓ | Vac |
| AC Frequency (Nominal) | 59.3 - 60 - 60.5[1] | | | | | | | Hz |
| Maximum Continuous Output Current @240V | 12.5 | 16 | 21 | 25 | 32 | 42 | 47.5 | A |
| Maximum Continuous Output Current @208V | - | 16 | - | 24 | - | - | 48.5 | A |
| Power Factor | 1, adjustable -0.85 to 0.85 | | | | | | | |
| GFDI Threshold | 1 | | | | | | | A |
| Utility Monitoring, Islanding Protection, Country Configurable Thresholds | Yes | | | | | | | |
| **INPUT** | | | | | | | | |
| Maximum DC Power @240V | 4650 | 5900 | 7750 | 9300 | 11800 | 15500 | 17650 | W |
| Maximum DC Power @208V | - | 5100 | - | 7750 | - | - | 15500 | W |
| Transformer-less, Ungrounded | Yes | | | | | | | |
| Maximum Input Voltage | 480 | | | | | | | Vdc |
| Nominal DC Input Voltage | 380 | | | | 400 | | | Vdc |
| Maximum Input Current @240V[2] | 8.5 | 10.5 | 13.5 | 16.5 | 20 | 27 | 30.5 | Adc |
| Maximum Input Current @208V[2] | - | 9 | - | 13.5 | - | - | 27 | Adc |
| Max. Input Short Circuit Current | 45 | | | | | | | Adc |
| Reverse-Polarity Protection | Yes | | | | | | | |
| Ground-Fault Isolation Detection | 600kΩ Sensitivity | | | | | | | |
| Maximum Inverter Efficiency | 99 | 99.2 | | | | | | % |
| CEC Weighted Efficiency | 99 | | | | | | 99 @ 240V<br>98.5 @ 208V | % |
| Nighttime Power Consumption | < 2.5 | | | | | | | W |

[1] For other regional settings please contact SolarEdge support
[2] A higher current source may be used; the inverter will limit its input current to the values stated

# Single Phase Inverter with HD-Wave Technology for North America

## SE3000H-US / SE3800H-US / SE5000H-US / SE6000H-US/ SE7600H-US / SE10000H-US / SE11400H-US

| Model Number | SE3000H-US | SE3800H-US | SE5000H-US | SE6000H-US | SE7600H-US | SE10000H-US | SE11400H-US | |
|---|---|---|---|---|---|---|---|---|
| **ADDITIONAL FEATURES** | | | | | | | | |
| Supported Communication Interfaces | RS485, Ethernet, ZigBee (optional), Cellular (optional) | | | | | | | |
| Revenue Grade Data, ANSI C12.20 | Optional[3] | | | | | | | |
| Inverter Commissioning | with the SetApp mobile application using built-in Wi-Fi Access Point for local connection | | | | | | | |
| Rapid Shutdown - NEC 2014 and 2017 690.12 | Automatic Rapid Shutdown upon AC Grid Disconnect | | | | | | | |
| **STANDARD COMPLIANCE** | | | | | | | | |
| Safety | UL1741, UL1741 SA, UL1699B, CSA C22.2, Canadian AFCI according to T.I.L. M-07 | | | | | | | |
| Grid Connection Standards | IEEE1547, Rule 21, Rule 14 (HI) | | | | | | | |
| Emissions | FCC Part 15 Class B | | | | | | | |
| **INSTALLATION SPECIFICATIONS** | | | | | | | | |
| AC Output Conduit Size / AWG Range | 1'' Maximum / 14-6 AWG | | | | | 1'' Maximum /14-4 AWG | | |
| DC Input Conduit Size / # of Strings / AWG Range | 1'' Maximum / 1-2 strings / 14-6 AWG | | | | | 1'' Maximum / 1-3 strings / 14-6 AWG | | |
| Dimensions with Safety Switch (HxWxD) | 17.7 x 14.6 x 6.8 / 450 x 370 x 174 | | | | | 21.3 x 14.6 x 7.3 / 540 x 370 x 185 | | in / mm |
| Weight with Safety Switch | 22 / 10 | | 25.1 / 11.4 | | 26.2 / 11.9 | 38.8 / 17.6 | | lb / kg |
| Noise | < 25 | | | | <50 | | | dBA |
| Cooling | Natural Convection | | | | | | | |
| Operating Temperature Range | -40 to +140 / -40 to +60[4] | | | | | | | °F / °C |
| Protection Rating | NEMA 4X (Inverter with Safety Switch) | | | | | | | |

[3] Revenue grade inverter P/N: SExxxxH-US000BNC4
[4] Full power up to at least 50°C / 122°F; for power de-rating information refer to: https://www.solaredge.com/sites/default/files/se-temperature-derating-note-na.pdf



RoHS

# Power Optimizer

## For North America

P320 / P340 / P370 / P400 / P405 / P505

POWER OPTIMIZER


## PV power optimization at the module-level

- Specifically designed to work with SolarEdge inverters
- Up to 25% more energy
- Superior efficiency (99.5%)
- Mitigates all types of module mismatch losses, from manufacturing tolerance to partial shading
- Flexible system design for maximum space utilization
- Fast installation with a single bolt
- Next generation maintenance with module-level monitoring
- Meets NEC requirements for arc fault protection (AFCI) and Photovoltaic Rapid Shutdown System (PVRSS)
- Module-level voltage shutdown for installer and firefighter safety



solaredge

# / Power Optimizer
## For North America
### P320 / P340 / P370 / P400 / P405 / P505

| Optimizer model (typical module compatibility) | P320 (for 60-cell modules) | P340 (for high-power 60-cell modules) | P370 (for higher-power 60 and 72-cell modules) | P400 (for 72 & 96-cell modules) | P405 (for thin film modules) | P505 (for higher current modules) | |
|---|---|---|---|---|---|---|---|
| **INPUT** | | | | | | | |
| Rated Input DC Power[1] | 320 | 340 | 370 | 400 | 405 | 505 | W |
| Absolute Maximum Input Voltage (Voc at lowest temperature) | 48 | | 60 | 80 | 125[2] | 83[2] | Vdc |
| MPPT Operating Range | 8 - 48 | | 8 - 60 | 8 - 80 | 12.5 - 105 | 12.5 - 83 | Vdc |
| Maximum Short Circuit Current (Isc) | 11 | | | 10.1 | | 14 | Adc |
| Maximum DC Input Current | 13.75 | | | 12.63 | | 17.5 | Adc |
| Maximum Efficiency | 99.5 | | | | | | % |
| Weighted Efficiency | 98.8 | | | | | 98.6 | % |
| Overvoltage Category | II | | | | | | |
| **OUTPUT DURING OPERATION (POWER OPTIMIZER CONNECTED TO OPERATING SOLAREDGE INVERTER)** | | | | | | | |
| Maximum Output Current | 15 | | | | | | Adc |
| Maximum Output Voltage | 60 | | | | 85 | | Vdc |
| **OUTPUT DURING STANDBY (POWER OPTIMIZER DISCONNECTED FROM SOLAREDGE INVERTER OR SOLAREDGE INVERTER OFF)** | | | | | | | |
| Safety Output Voltage per Power Optimizer | 1 ± 0.1 | | | | | | Vdc |
| **STANDARD COMPLIANCE** | | | | | | | |
| EMC | FCC Part15 Class B, IEC61000-6-2, IEC61000-6-3 | | | | | | |
| Safety | IEC62109-1 (class II safety), UL1741 | | | | | | |
| RoHS | Yes | | | | | | |
| **INSTALLATION SPECIFICATIONS** | | | | | | | |
| Maximum Allowed System Voltage | 1000 | | | | | | Vdc |
| Compatible inverters | All SolarEdge Single Phase and Three Phase inverters | | | | | | |
| Dimensions (W x L x H) | 129 x 153 x 27.5 / 5.1 x 6 x 1.1 | | | 129 x 153 x 33.5 / 5.1 x 6 x 1.3 | 129 x 159 x 49.5 / 5.1 x 6.3 x 1.9 | 129 x 162 x 59 / 5.1 x 6.4 x 2.3 | mm / in |
| Weight (including cables) | 630 / 1.4 | | | 750 / 1.7 | 845 / 1.9 | 1064 / 2.3 | gr / lb |
| Input Connector | MC4[3] | | | | | | |
| Output Wire Type / Connector | Double Insulated; MC4 | | | | | | |
| Output Wire Length | 0.95 / 3.0 | | 1.2 / 3.9 | | | | m / ft |
| Input Wire Length | 0.16 / 0.52 | | | | | | m / ft |
| Operating Temperature Range | -40 - +85 / -40 - +185 | | | | | | ˚C / ˚F |
| Protection Rating | IP68 / NEMA6P | | | | | | |
| Relative Humidity | 0 - 100 | | | | | | % |

[1] Rated STC power of the module. Module of up to +5% power tolerance allowed
[2] NEC 2017 requires max input voltage be not more than 80V
[3] For other connector types please contact SolarEdge

| PV System Design Using a SolarEdge Inverter[4][5] | | Single Phase HD-Wave | Single phase | Three Phase 208V | Three Phase 480V | |
|---|---|---|---|---|---|---|
| Minimum String Length (Power Optimizers) | P320, P340, P370, P400 | 8 | | 10 | 18 | |
| | P405 / P505 | 6 | | 8 | 14 | |
| Maximum String Length (Power Optimizers) | | 25 | | 25 | 50[6] | |
| Maximum Power per String | | 5700 (6000 with SE7600-US - SE11400-US) | 5250 | 6000[7] | 12750[8] | W |
| Parallel Strings of Different Lengths or Orientations | | Yes | | | | |

[4] For detailed string sizing information refer to: http://www.solaredge.com/sites/default/files/string_sizing_na.pdf
[5] It is not allowed to mix P405/P505 with P320/P340/P370/P400 in one string
[6] A string with more than 30 optimizers does not meet NEC rapid shutdown requirements; safety voltage will be above the 30V requirement
[7] For SE14.4KUS/SE43.2KUS: It is allowed to install up to 6,500W per string when 3 strings are connected to the inverter (3 strings per unit for SE43.2KUS) and when the maximum power difference between the strings is up to 1,000W
[8] For SE30KUS/SE33.3KUS/SE66.6KUS/SE100KUS: It is allowed to install up to 15,000W per string when 3 strings are connected to the inverter (3 strings per unit for SE66.6KUS/SE100KUS) and when the maximum power difference between the strings is up to 2,000W



CE RoHS

pe.eaton.com

# Eaton general duty cartridge fuse safety switch

**DG222NRB**

**UPC:**782113144221

**Dimensions:**

- **Height:** 14.37 IN
- **Length:** 7.35 IN
- **Width:** 8.4 IN

**Weight:**10 LB

**Notes:**Maximum hp ratings apply only when dual element fuses are used. 3-Phase hp rating shown is a grounded B phase rating, UL listed.

**Warranties:**

- Eaton Selling Policy 25-000, one (1) year from the date of installation of the Product or eighteen (18) months from the date of shipment of the Product, whichever occurs first.

**Specifications:**

- **Type:** General duty, cartridge fused
- **Amperage Rating:** 60A
- **Enclosure:** NEMA 3R
- **Enclosure Material:** Painted galvanized steel
- **Fuse Class Provision:** Class H fuses
- **Fuse Configuration:** Fusible with neutral
- **Number Of Poles:** Two-pole
- **Number Of Wires:** Three-wire
- **Product Category:** General duty safety switch
- **Voltage Rating:** 240V

**Supporting documents:**

- Eatons Volume 2-Commercial Distribution
- Eaton Specification Sheet - DG222NRB

**Certifications:**

- UL Listed

**Product compliance:** No Data

# POWERWALL

Tesla Powerwall is a fully-integrated AC battery system for residential or light commercial use. Its rechargeable lithium-ion battery pack provides energy storage for solar self-consumption, time-based control, and backup.

Powerwall's electrical interface provides a simple connection to any home or building. Its revolutionary compact design achieves market-leading energy density and is easy to install, enabling owners to quickly realize the benefits of reliable, clean power.


## PERFORMANCE SPECIFICATIONS

| | |
|---|---|
| **AC Voltage (Nominal)** | 120/240 V |
| **Feed-In Type** | Split Phase |
| **Grid Frequency** | 60 Hz |
| **Total Energy** | 14 kWh |
| **Usable Energy** | 13.5 kWh |
| **Real Power, max continuous** | 5 kW (charge and discharge) |
| **Real Power, peak (10 s, off-grid/backup)** | 7 kW (charge and discharge) |
| **Apparent Power, max continuous** | 5.8 kVA (charge and discharge) |
| **Apparent Power, peak (10 s, off-grid/backup)** | 7.2 kVA (charge and discharge) |
| **Maximum Supply Fault Current** | 10 kA |
| **Maximum Output Fault Current** | 32 A |
| **Overcurrent Protection Device** | 30 A |
| **Imbalance for Split-Phase Loads** | 100% |
| **Power Factor Output Range** | +/– 1.0 adjustable |
| **Power Factor Range (full-rated power)** | +/– 0.85 |
| **Internal Battery DC Voltage** | 50 V |
| **Round Trip Efficiency[1,3]** | 90% |
| **Warranty** | 10 years |

[1]Values provided for 25°C (77°F), 3.3 kW charge/discharge power.
[2]In Backup mode, grid charge power is limited to 3.3 kW.
[3]AC to battery to AC, at beginning of life.

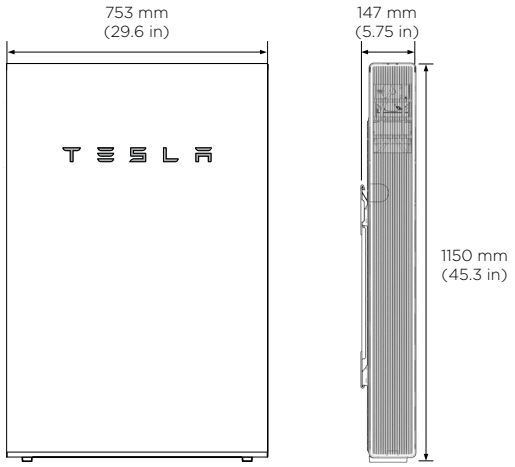
## COMPLIANCE INFORMATION

| | |
|---|---|
| **Certifications** | UL 1642, UL 1741, UL 1973, UL 9540, IEEE 1547, UN 38.3 |
| **Grid Connection** | Worldwide Compatibility |
| **Emissions** | FCC Part 15 Class B, ICES 003 |
| **Environmental** | RoHS Directive 2011/65/EU |
| **Seismic** | AC156, IEEE 693-2005 (high) |

## MECHANICAL SPECIFICATIONS

| | |
|---|---|
| **Dimensions[1]** | 1150 mm x 755 mm x 147 mm (45.3 in x 29.6 in x 5.75 in) |
| **Weight[1]** | 114 kg (251.3 lbs) |
| **Mounting options** | Floor or wall mount |

[1]Dimensions and weight differ slightly if manufactured before March 2019. Contact Tesla for additional information.

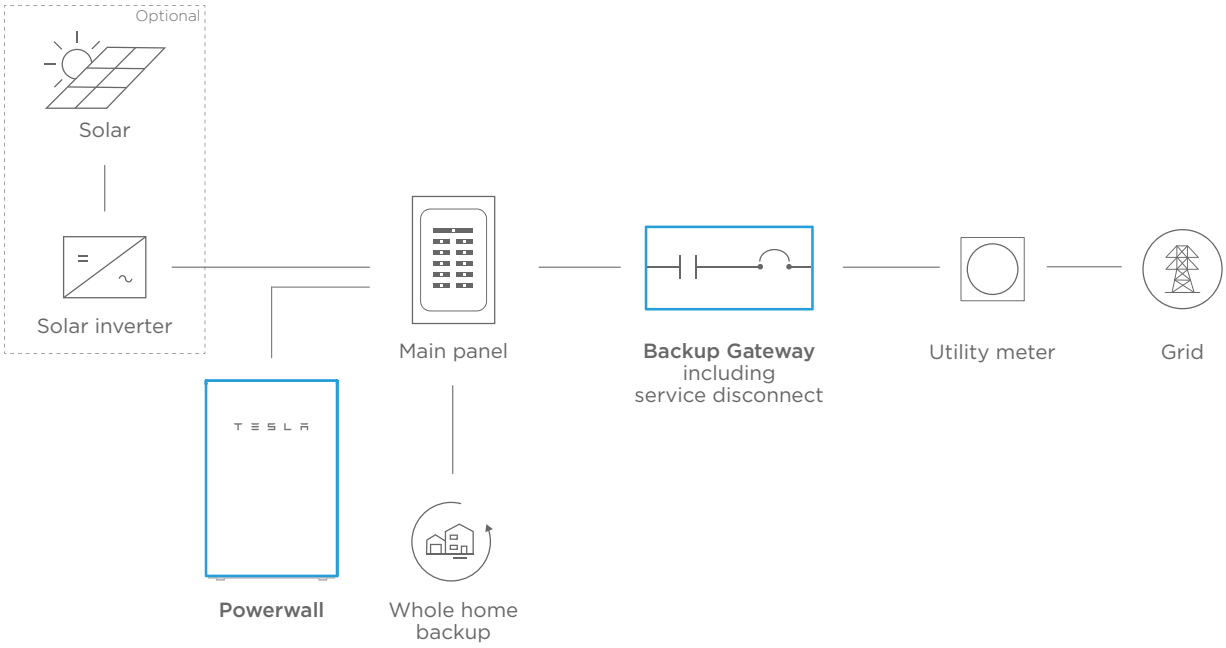



## ENVIRONMENTAL SPECIFICATIONS

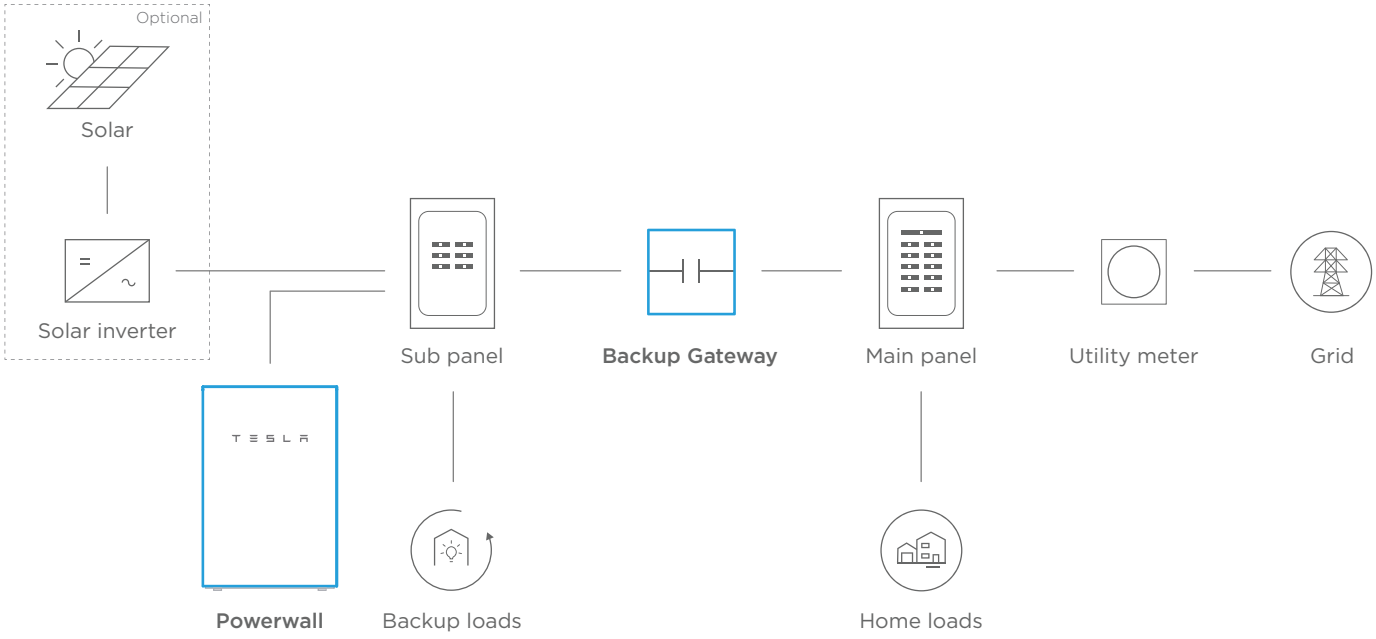
| | |
|---|---|
| **Operating Temperature** | –20°C to 50°C (–4°F to 122°F) |
| **Recommended Temperature** | 0°C to 30°C (32°F to 86°F) |
| **Operating Humidity (RH)** | Up to 100%, condensing |
| **Storage Conditions** | –20°C to 30°C (–4°F to 86°F)<br>Up to 95% RH, non-condensing<br>State of Energy (SoE): 25% initial |
| **Maximum Elevation** | 3000 m (9843 ft) |
| **Environment** | Indoor and outdoor rated |
| **Enclosure Type** | NEMA 3R |
| **Ingress Rating** | IP67 (Battery & Power Electronics)<br>IP56 (Wiring Compartment) |
| **Wet Location Rating** | Yes |
| **Noise Level @ 1m** | < 40 dBA at 30°C (86°F) |

# TYPICAL SYSTEM LAYOUTS

## WHOLE HOME BACKUP



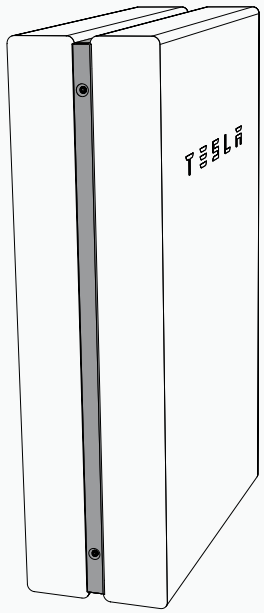

## PARTIAL HOME BACKUP



# POWERWALL
## Multi-Powerwall Stack Kit

The Stack Kit for Tesla Powerwall joins two floor-mounted Powerwall units in front-to-back multi-Powerwall installations. Side clips and a top cover secure the units and prevent debris from falling between them. An optional bridge assembly conceals wire runs between the Powerwalls, preserving the clean lines of the installation.

Up to 3 floor-mounted Powerwalls can be joined using two Stack Kits. For systems with more than 3 Powerwalls, separate groups of 3 units should be assembled.



## ENVIRONMENTAL SPECIFICATIONS

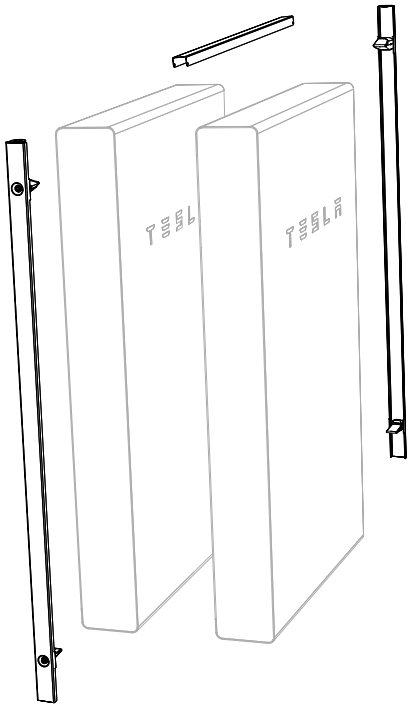
| | |
|---|---|
| **Operating Temperature** | –20°C to 50°C (–4°F to 122°F) |
| **Operating Humidity (RH)** | Up to 100%, condensing |
| **Environment** | Indoor and outdoor rated |
| **Ingress Rating** | IP67 |

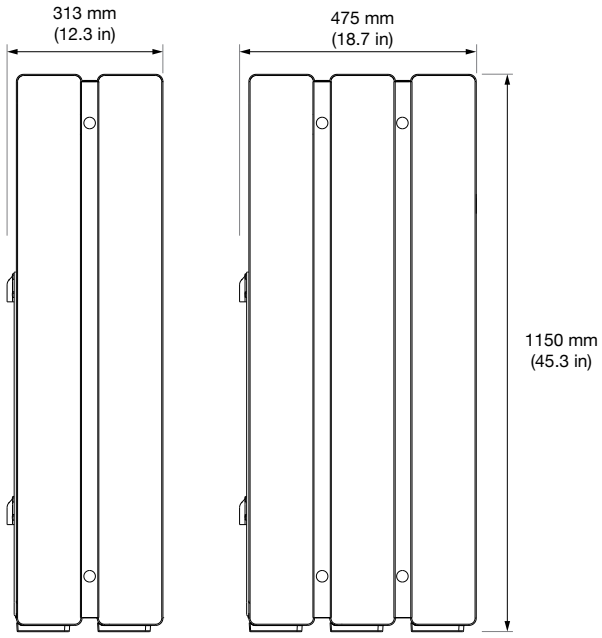
## COMPLIANCE INFORMATION

| | |
|---|---|
| **Certifications** | UL 1741, IEC 62109-1, CSA C22.2.107.1 |
| **Environmental** | RoHS Directive 2011/65/EU, REACH Regulation |
| **Seismic** | AC156, IEEE 693-2005 (high) |

## MECHANICAL SPECIFICATIONS

| | |
|---|---|
| **Stack Kit Shipping Dimensions** | 1134 mm x 175 mm x 48 mm (44.6 in x 6.9 in x 1.9 in) |
| **Stack Kit Shipping Weight** | 2.2 kg (4.8 lbs) |
| **Materials** | Powder-coated steel, stainless steel, galvanized steel, high-impact plastic |
| **2-Powerwall Stack Dimensions** | 1150 mm x 755 mm x 313 mm (45.3 in x 29.7 in x 12.3 in) |
| **Weight (including 2 Powerwalls)** | 253 kg (556 lbs) |
| **3-Powerwall Stack Dimensions** | 1150 mm x 755 mm x 475 mm (45.3 in x 29.7 in x 18.7 in) |
| **Weight (including 3 Powerwalls)** | 379.5 kg (837 lbs) |





# POWERWALL
## Backup Gateway 2

The Backup Gateway 2 for Tesla Powerwall provides energy management and monitoring for solar self-consumption, time-based control, and backup.

The Backup Gateway 2 controls connection to the grid, automatically detecting outages and providing a seamless transition to backup power. When equipped with a main circuit breaker, the Backup Gateway 2 can be installed at the service entrance. When the optional internal panelboard is installed, the Backup Gateway 2 can also function as a load center.

The Backup Gateway 2 communicates directly with Powerwall, allowing you to monitor energy use and manage backup energy reserves from any mobile device with the Tesla app.

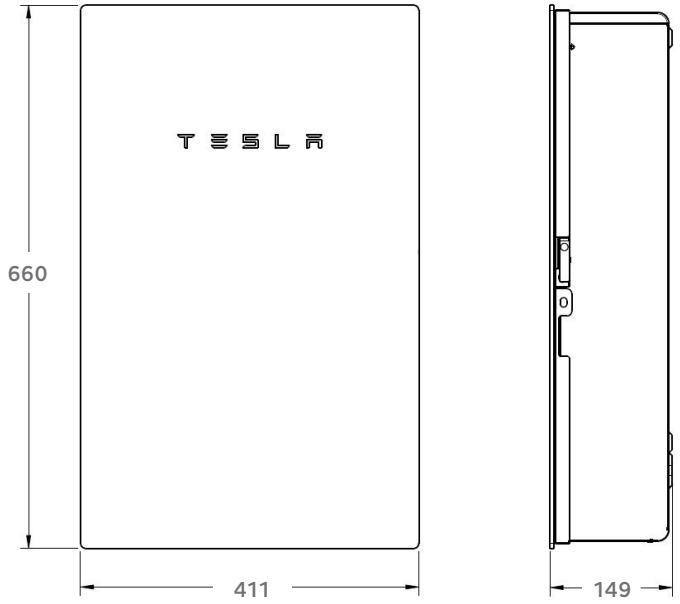
## PERFORMANCE SPECIFICATIONS

| | |
|---|---|
| **AC Voltage (Nominal)** | 120/240V |
| **Feed-In Type** | Split Phase |
| **Grid Frequency** | 60 Hz |
| **Current Rating** | 200 A |
| **Maximum Input Short Circuit Current** | 10 kA[1] |
| **Overcurrent Protection Device** | 100-200A; Service Entrance Rated[1] |
| **Overvoltage Category** | Category IV |
| **AC Meter** | Revenue accurate (+/– 0.2 %) |
| **Primary Connectivity** | Ethernet, Wi-Fi |
| **Secondary Connectivity** | Cellular (3G, LTE/4G)[2] |
| **User Interface** | Tesla App |
| **Operating Modes** | Support for solar self-consumption, time-based control, backup, and off-grid |
| **Backup Transition** | Automatic disconnect for seamless backup |
| **Modularity** | Supports up to 10 AC-coupled Powerwalls |
| **Optional Internal Panelboard** | 200A 6-space / 12 circuit Eaton BR Circuit Breakers |
| **Warranty** | 10 years |

[1] When protected by Class J fuses, Backup Gateway 2 is suitable for use in circuits capable of delivering not more than 22kA symmetrical amperes.
[2] The customer is expected to provide internet connectivity for Backup Gateway 2; cellular should not be used as the primary mode of connectivity. Cellular connectivity subject to network operator service coverage and signal strength.

## MECHANICAL SPECIFICATIONS

| | |
|---|---|
| **Dimensions** | 660 mm x 411 mm x 149 mm (26 in x 16 in x 6 in) |
| **Weight** | 20.4 kg (45 lb) |
| **Mounting options** | Wall mount, Semi-flush mount |




## COMPLIANCE INFORMATION

| | |
|---|---|
| **Certifications** | UL 67, UL 869A, UL 916, UL 1741 PCS CSA 22.2 0.19, CSA 22.2 205 |
| **Emissions** | FCC Part 15, ICES 003 |

## ENVIRONMENTAL SPECIFICATIONS

| | |
|---|---|
| **Operating Temperature** | –20°C to 50°C (–4°F to 122°F) |
| **Operating Humidity (RH)** | Up to 100%, condensing |
| **Maximum Elevation** | 3000 m (9843 ft) |
| **Environment** | Indoor and outdoor rated |
| **Enclosure Type** | NEMA 3R |

# Powerwall 2 AC & Backup Gateway: Permitting & Inspection Support for Tesla Home Energy Storage System

## Summary Description

Powerwall 2 AC (*Powerwall*) and the Backup Gateway (*Gateway*) comprise a state-of-the-art battery system for residential and light commercial applications. Together, they enable energy stored from the grid (or renewable sources, like solar), to be used at night or to provide backup power in a grid outage.

Powerwall arrives at the job site as a factory assembly that includes:

- Lithium-ion battery cells
- Isolated DC/DC converter (to step up the battery's voltage)
- Integrated AC inverter (to convert low voltage DC from the battery to AC for the home or business)
- Liquid thermal management system (to maximize battery performance)

The battery cells inside Powerwall are the components closest to a conventional battery. No one is ever exposed to these cells because they are electrically and physically isolated from contact at all times.

All Powerwall installations require the Gateway, which serves several functions:

- Monitors the grid for outage
- Instantly isolates Powerwall from the grid (during grid outage, or when providing backup power)
- Communicates with the Powerwall (via communication cables)
- Monitors & manages how energy is used (including self-consumption, load-shifting & backup)
- Functions as both *service entrance* and *disconnect* (when installed with a breaker)

When a grid outage is detected, the Gateway instantly isolates Powerwall from the grid using a microprocessor-controlled power contactor.

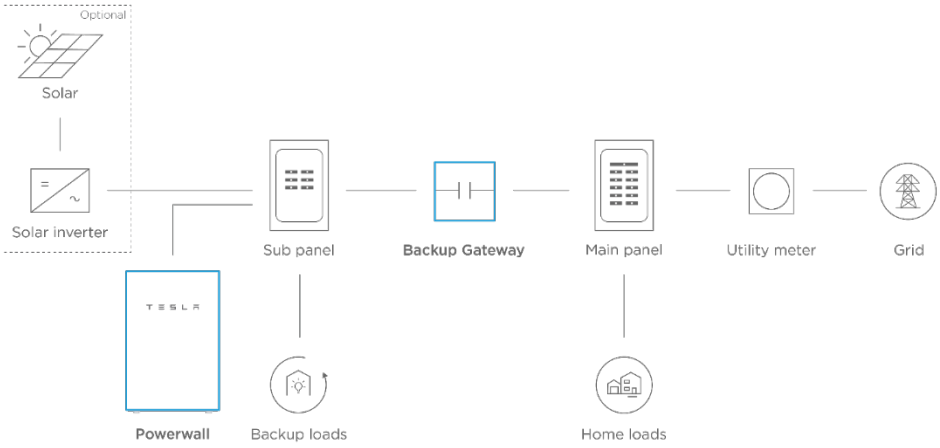

**Powerwall Installation Example for Whole-Home Backup (Gateway as Service Entrance and Disconnect)**

## Key NEC References

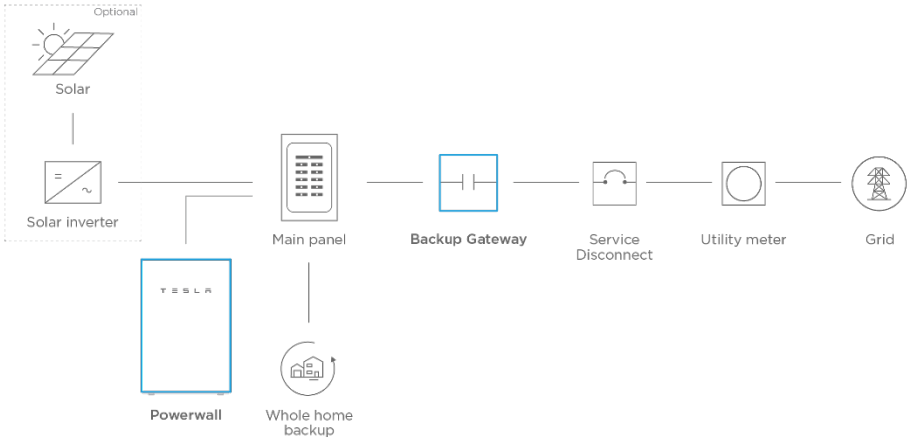
Applicable NEC references may vary with the adopted edition of the NEC and site-specific configurations. Generally, Chapters 1 through 4 as modified by the following NEC sections will apply to Powerwall and the Gateway:

| Article or Section | Description | NEC Edition |
|---|---|---|
| 705 | Interconnected Electric Power Production Sources | 2014, 2017 |
| 690.10 | Stand Alone Systems | 2014 |
| 690.71 | Storage Batteries | 2014 |
| 710 | Stand Alone Systems | 2017 |
| 706 | Energy Storage Systems | 2017 |

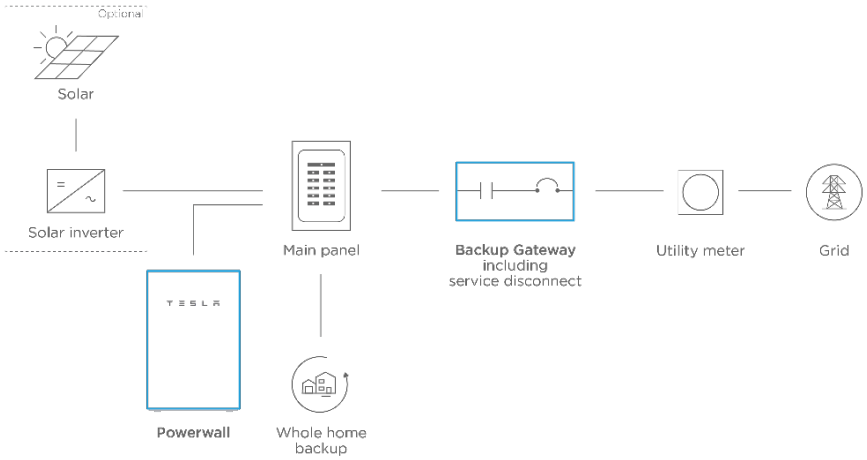
# Most Common Configurations




*Partial Home Backup (with or without solar)*




*Whole Home Backup (with or without solar)*




*Whole Home Backup (using Gateway as Service Entrance & Disconnect, with or without solar)*

# Key Specifications & Certifications

*(Full datasheets provided separately)*

### Powerwall Electrical

| | |
|---|---|
| Energy | 13.5 kWh |
| AC Voltage (Nominal) and Maximum Continuous Current | 120/240 V: 24 A |
| Frequency (Nominal) | 60 Hz |
| Power, max continuous | 5 kW (charge and discharge) |
| Power, peak (10 seconds) | 7 kW (charge and discharge) |
| Overvoltage Category | Category III |
| Max Supply Fault Current | 10 kA |
| Max Output Fault Current | 32 A |

### Powerwall Environmental & Certifications

| | |
|---|---|
| Operating Temperature | -20°C to 50°C (-4°F to 122°F) |
| Enclosure Type | NEMA 3R |
| Ingress Rating | IP67 (battery and power electronics)<br>IP56 (wiring) |
| Wet Location Rating | Yes |
| Seismic Rating | AC156, IEEE 693-2005 (high) |
| Safety Certifications (partial list) | UL 1642, UL 1741SA, UL 1973, UL 9540 |
| NRTL | Intertek/ETL |

### Powerwall Mechanical

| | |
|---|---|
| Height | 45.3 in |
| Width | 29.7 in |
| Depth | 6.1 in |
| Weight | 276 lbs |

### Gateway Electrical

| | |
|---|---|
| Disconnect Current | 200 A |
| Overcurrent Protection Breaker | 100-200 A (Service Entrance configuration) |
| Overvoltage Category | Category IV |
| Fault Current Withstand Rating | 10 kAIC (Configurable to 22 kAIC) |
| AC Meter | Revenue grade |
| Service Rating | Suitable for Use as Service Equipment |

### Gateway Environmental & Certifications

| | |
|---|---|
| Operating Temperature | -20°C to 50°C (-4°F to 122°F) |
| Enclosure Type | NEMA 3R |
| Ingress Rating | IP44 |
| Safety Certifications (partial list) | UL 1642, UL 1741, IEC 61000-6-3, IEC 62109-1 |
| NRTL | Intertek/ETL |

### Gateway Mechanical

| | |
|---|---|
| Height | 29.1 in |
| Width | 14.9 in |
| Depth | 5.1 in |
| Weight | 36 lbs |

# Frequently Asked Questions

**Are Powerwall and the Gateway listed equipment?**

Yes. Powerwall and the Gateway are listed to the applicable product standards by Intertek/ETL, an OSHA-approved Nationally Recognized Testing Laboratory (NRTL). See the table above for a partial list of certifications. If physical certificates are required, please email powerwall@tesla.com.

**What safety features does Powerwall include to avoid thermal runaway?**

To resist single cell thermal runaway, Powerwall complies with requirements in UL 1973 and IEC 62619. For example, UL 1973 includes an internal fire test that ensures a runaway in one cell can't propagate to neighboring cells. Onboard sensors and the battery management system (BMS) provide multiple layers of protection to detect and stop precursors to thermal runaway.

**How much does the AC Powerwall weigh, and will it comply with seismic requirements when wall-mounted?**

Powerwall weighs 276 lbs. and complies with seismic requirements when wall-mounted according to manufacturer's instructions. It has been evaluated to ICC Acceptance Criteria AC156 for seismic requirements. Installation methods also comply with IEEE Standard 693-2005 for seismic design.

**Is guidance available for emergency personnel working around a Powerwall that has been physically damaged?**

Yes. An Emergency Response Guide is available on request. Emergency and maintenance personnel can work safely around Powerwall after opening the system's AC disconnect and/or breaker on the grid side. Water is the recommended suppressant in case of a fire involving a lithium-ion battery and will not exacerbate a fire involving lithium-ion cells.

**Does Powerwall require additional venting to prevent the accumulation of flammable or explosive gases?**

No. Unlike conventional lead-acid batteries, which produce hydrogen gas, the individual cells in the Powerwall are hermetically sealed and do not require additional ventilation. NEC [480.9(A)], NFPA 1 Chapter 52, and the 2018 IFC, all make clear venting is not required for lithium-ion batteries.

**How much electrolyte is in Powerwall?**

Tesla lithium-ion battery packs do not contain free liquid electrolyte and do not pose a liquid release hazard. If an enclosure is punctured, there are no electrolytes to "spill" onto the floor. Secondary containment measures are not needed.

**NOTE:** IFC Section 608 does not require spill control or neutralization for lithium-ion battery systems. Secondary containment is not applicable or required for this technology.

**Is Powerwall's battery pack low voltage?**

Yes. The internal battery pack operates at less than 50 VDC nominal. Unlike legacy battery systems, Powerwall is a fully enclosed, factory-listed assembly with no accessible battery terminals or live parts. Powerwall's output is AC and matches that of the serving utility. Powerwall's onboard inverter functions exactly like a solar PV inverter.

**Are the working clearances outlined in the NEC 110.26 applicable to Powerwall?**

No. Because Powerwall will never require examination, adjustment, servicing, or maintenance while energized, working clearances in Article 110.26 do not apply.

**Does Powerwall require a separate disconnect?**

No. Powerwall's onboard switch disconnects all ungrounded conductors and complies with Article 690.71 (2014) and 706.7 (2017).

**NOTE:** These articles require a second disconnecting means at the connected equipment when:

- Separated by a wall or partition, or
- Input and output terminals are more than 5ft away.

This second disconnect will typically be the 2P/30A breaker installed at the point of connection.

**Can Powerwall be installed outdoors?**

Yes. Powerwall is a NEMA Type 3R enclosure and can be installed outdoors.

**What prevents Powerwall from back-feeding the utility grid during a power outage?**

During a power outage, the Gateway automatically isolates the home from the grid per IEEE 1547. Powerwall and Gateway are both listed to UL 1741 because they are subject to the same anti-islanding rules as a typical grid-interactive PV system. Gateway reconnects to the grid once it is stable for at least 5 minutes.

**What is the maximum number of circuits that can be backed up for a single Powerwall?**

The number of circuits that a single Powerwall can back up isn't specified. The duration of backup power is a function of *Power * Time*, stated in Watt-hours. The maximum continuous output at any given time is limited to 5000W, with a peak output capacity of 7000W for 10 seconds. The number of loads and circuits the customer wants backed up will determine the overall system size, including total number of Powerwalls required.

**Is Powerwall required to be capable of backing up all the home's loads simultaneously?**

No. When Powerwall is operating as a *stand-alone system,* as permitted in 705.40, available current must be *"equal to or greater than the load posed by the largest single utilization equipment connected to the system"* (not including general lighting loads). Guidance on system sizing may be found in NEC Articles 690.10 [2014] and 710.15(A) [2017].

**When in backup mode, what happens if the load exceeds Powerwall's rated output current?**

Powerwall automatically shuts down. Powerwall's inverter is an inherently power- and current-limited device. If Powerwall is operating at full rated output current and more load is applied, it simply cannot produce more current. The inverter will sense the corresponding voltage change and immediately shut off. There is no risk for over-discharging above the rated nameplate of Powerwall.

# Inspection Guide

In addition to a simpler installation process, Powerwall and Gateway systems are easier to review for safety and code compliance. Primary code references are from the 2014 NEC. Additional references [in brackets] are from the 2017 NEC.

## General Requirements

- Listing verification - Equipment bears the mark of a Nationally Recognized Testing Laboratory. 90.7, [706.5]
- Manufacturer's installation instructions followed. 110.3(B)
- The completed installation appears to be neat and of good workmanship. 110.12
- Working clearances are in accordance with 110.26 for any components that are "likely to require examination, adjustment, servicing, or maintenance while energized."
    - Note that Powerwall has no accessible DC battery interconnections within the unit, and does not require maintenance while energized.
    - The ventilation clearance requirements found in 480.9 do not apply to this technology. Tesla Powerwall complies with [706.10(A)] using a pre-engineered ventilation solution.

## Wiring Methods

- All conduit and fittings properly installed per the respective article in Chapter 3 of the NEC.
- Conduit is adequately secured and supported. 3xx.30
- Raceways containing insulated circuit conductors 4 AWG and larger are protected from abrasion by an identified fitting providing a smoothly rounded insulating surface. 300.4(G)
- Residential Energy Storage equipment grounding conductor is identified as either bare, green, or green with continuous yellow stripe(s). 250.119
- Grounded conductor identified properly. 200.6(A), (B)

## Overcurrent Protection and Wire Sizing

Conductors and OCPDs are adequately sized per Articles 240 and 310 unless modified by 690.9(A), 690.10(B), or [706.20] and [706.21].

## Disconnecting Means

- Disconnecting means are provided to disconnect the energy storage device from all ungrounded conductors of all sources. 690.15 and/or [706.7]. This requirement is met by the integrated disconnect switch.
- Where the energy storage device output terminals are more than 1.5 m (5 ft) from the connected equipment, or where output circuits pass through a wall or partition, a disconnecting means and overcurrent protection shall be provided at the energy storage device end of the circuit. 690.71(H), [706.7(E)]. The Powerwall complies with both the letter and the intent of the NEC:
    - As previously mentioned, the Powerwall is an inherently current-limiting device that will not contribute fault currents to the AC output circuit. It is important to note that the 2017 NEC has removed this overcurrent requirement altogether and clarified that the intent was to protect the DC conductors of a conventional battery.
    - The integrated disconnect satisfies the requirement for the energy storage device end of the circuit.
    - If the integrated disconnect is not within sight of the connected equipment, the 2P/30A breaker installed at the point of connection is the additional disconnect required by 690.71(H)(4).

## Labeling

- A sign that indicates the type and location of on-site optional power sources is placed at building utility service-entrance location. 705.10, [706.11]
- Equipment fed by multiple sources are marked to indicate all sources of supply. 705.12(D)(3).
- Where the integrated disconnect and the 2P/30A breaker are not within sight, a plaque or directory shall be installed at each disconnect indicating the location of the other disconnecting means. 690.71(H)(5) or [706.7(E)(5)].

# Additional resources

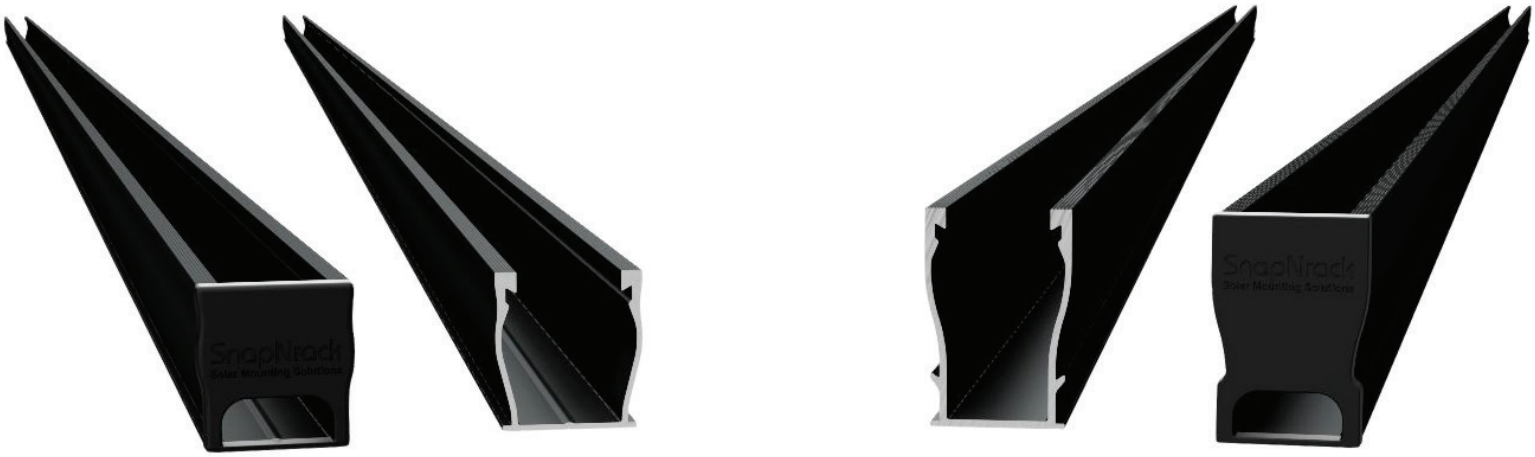
For compliance questions, a complete list of FAQs, or to request a Powerwall presentation for your building department, fire department or trade group (such as ICC and IAEI chapters) email CodeCompliance@tesla.com.

SEAC, the Sustainable Energy Action Committee, is a not-for-profit partnership of AHJs, testing laboratories and industry. SEAC has created free guidelines for building officials to plan check, correct and inspect storage battery systems for one- and two-family dwellings, available for download here.

SnapNrack™
Solar Mounting Solutions

UR-40
UR-60

# Ultra Rail



## The Ultimate Value in Rooftop Solar

- Industry leading Wire Management Solutions
- Mounts available for all roof types
- Single Tool Installation
- All SnapNrack Module Clamps & Accessories are compatible with both rail profiles

## Start Installing Ultra Rail Today

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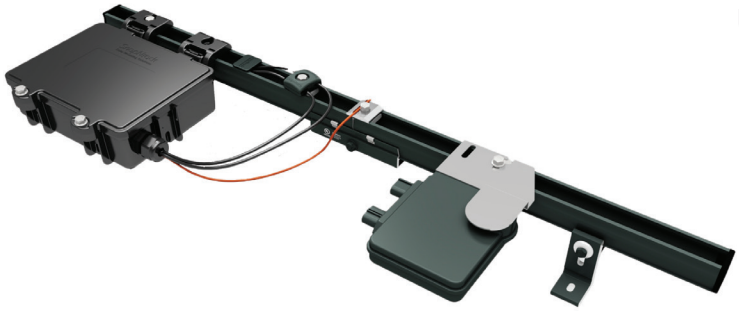
| **WHERE TO BUY** | snapnrack.com/where-to-buy |

# SnapNrack Ultra Rail System

**A sleek, straightforward rail solution for mounting solar modules on all roof types. Ultra Rail features two rail profiles; UR-40 is a lightweight rail profile that is suitable for most geographic regions and maintains all the great features of SnapNrack rail, while UR-60 is a heavier duty rail profile that provides a larger rail channel and increased span capabilities. Both are compatible with all existing mounts, module clamps, and accessories for ease of install.**

## The Entire System is a Snap to Install

- New Ultra Rail Mounts include snap-in brackets for attaching rail
- Compatible with all the SnapNrack Mid Clamps and End Clamps customers love
- Universal End Clamps and snap-in End Caps provide a clean look to the array edge



## Unparalleled Wire Management

- Open rail channel provides room for running wires resulting in a long-lasting quality install
- Industry best wire management offering includes Junction Boxes, Universal Wire Clamps, MLPE Attachment Kits, and Conduit Clamps
- System is fully bonded and listed to UL 2703 Standard

## Heavy Duty UR-60 Rail

- UR-60 rail profile provides increased span capabilities for high wind speeds and snow loads
- Taller, stronger rail profile includes profile-specific rail splice and end cap
- All existing mounts, module clamps, and accessories are retained for the same great install experience


# Quality. Innovative. Superior.

SnapNrack Solar Mounting Solutions are engineered to optimize material use and labor resources and improve overall installation quality and safety.

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OVERVIEW OF THE SNAPNRACK ULTRA RAIL SYSTEM INSTALLED ON A TYPICAL ROOF

REFER TO SPECIFIC "ATTACHMENT DETAIL" FOR DETAILS ON ATTACHING AND WATERPROOFING THE VARIOUS SNAPNRACK ROOF ATTACHMENT PRODUCTS

REFER TO SPECIFIC "COMPONENT DETAIL" FOR DETAILS ON VARIOUS SNAPNRACK ACCESSARY AND COMPONENT PRODUCTS

BOTH THE SNAPNRACK, UNIVERSAL END CLAMP AND SNAPNRACK, ULTRA RAIL END CLAMP CAN BE USED ON END MODULES

MODULES MAY BE CLAMPED ON SHORT OR LONG SIDE PER MODULE MANUFACTURER REQUIREMENTS

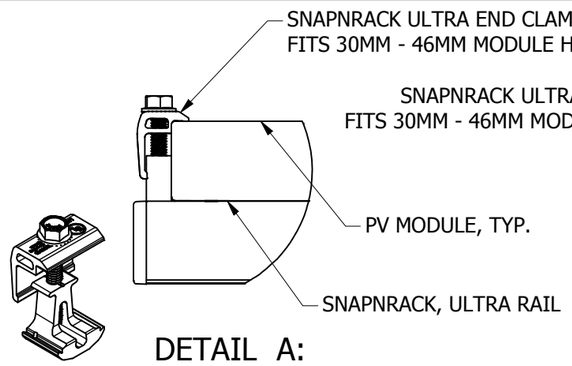
RAILS MAY BE MOUNTED UP/DOWN OR ACROSS THE SLOPE OF THE ROOF

REFER TO SNAPNRACK INSTALLATION MANUAL FOR 5/16"Ø HARDWARE TORQUE SPECIFICATIONS

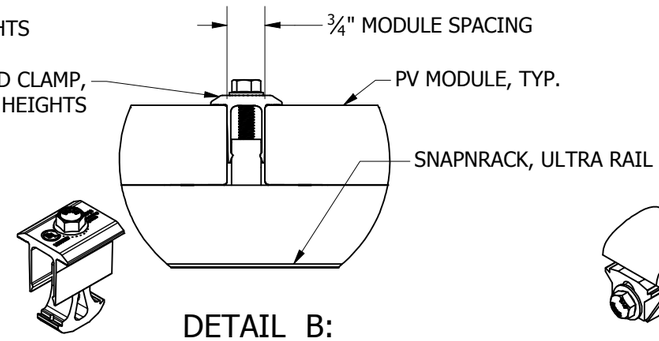
BIN: ALL

REVISION:

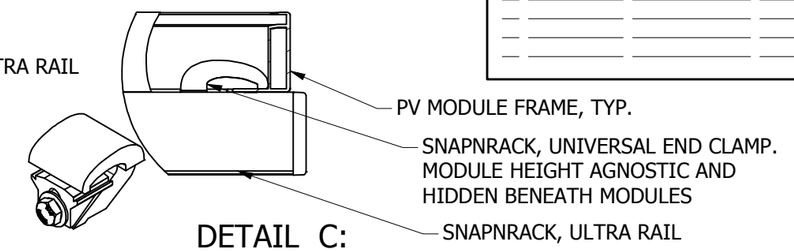
| | | | |
|---|---|---|---|
| 1 | 5/7/2019 | NEW DETAIL | MJA |
| 2 | 1/3/2020 | ULTRA CLAMPS | MJA |



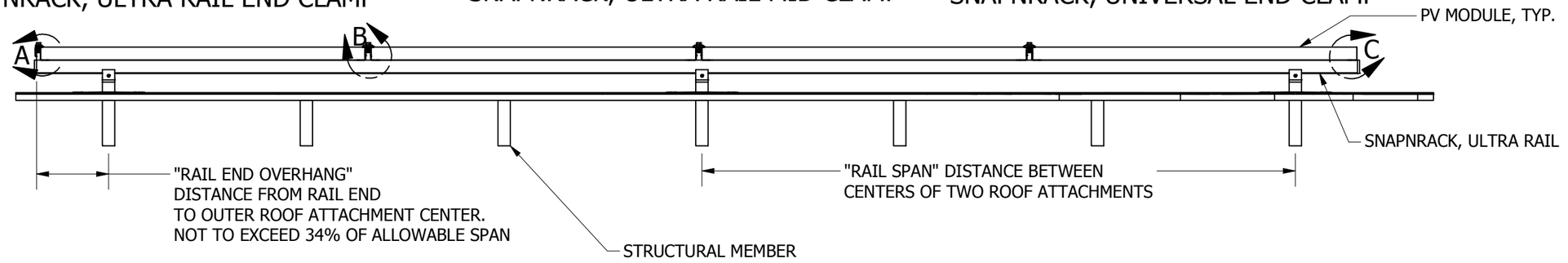

DETAIL A:
SNAPNRACK, ULTRA RAIL END CLAMP

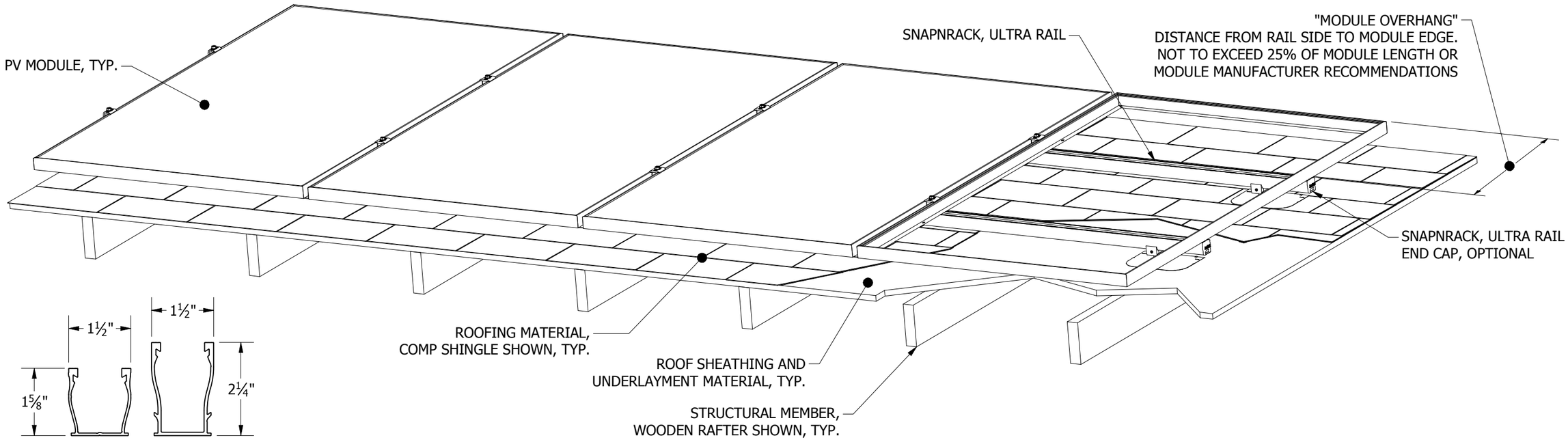



DETAIL B:
SNAPNRACK, ULTRA RAIL MID CLAMP




DETAIL C:
SNAPNRACK, UNIVERSAL END CLAMP







UR-40 RAIL | UR-60 RAIL
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| | | | | | |
|---|---|---|---|---|---|
| DESIGNER: M.AFFENTRANGER<br>DRAFTER: M.AFFENTRANGER<br>APPROVED BY: B.PETERSON | SCALE: DNS<br>DATE: 1/3/2020 | DRAWING NUMBER: SNR-DC-00329 | DESCRIPTION: ULTRA RAIL, SYSTEM OVERVIEW, TYPICAL | REV 2 |

SNAPNRACK ULTRA RAIL UMBRELLA L FOOT WITH UMBRELLA FLASHING FOR COMPOSTION ROOF MOUNTING

REFER TO SNAPNRACK ENGINEERING CHARTS FOR APPLICABLE RAIL SPANS. "BIN" NUMBER ON CHART SHOULD MATCH "BIN" NUMBER ON THIS DRAWING

5/16"Ø S.S. UMBRELLA LAG SCREW MUST EMBED A MIN. OF 2½" INTO STRUCTURAL MEMBER

REFER TO SNAPNRACK INSTALLATION MANUAL FOR 5/16"Ø HARDWARE TORQUE SPECIFICATIONS

RAIL CAN BE MOUNTED ON EITHER SIDE OF THE L-FOOT

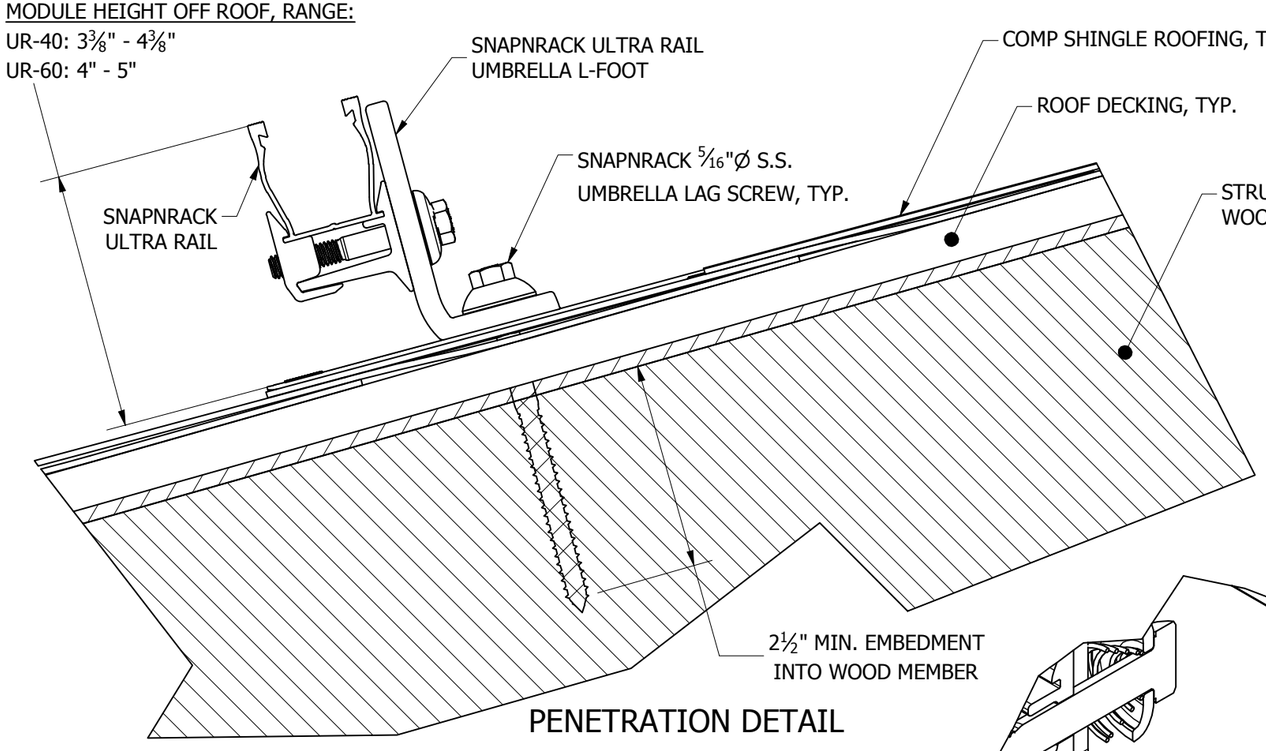
FOR LEVELING DETAILS, REFER TO SNAPNRACK DETAIL DRAWING "SNR-DC-00332 ULTRA RAIL, COMPONENT DETAIL, LEVELING EXTENSION KIT"

MODULE HEIGHT OFF ROOF, RANGE:
UR-40: 3⅜" - 4⅜"
UR-60: 4" - 5"

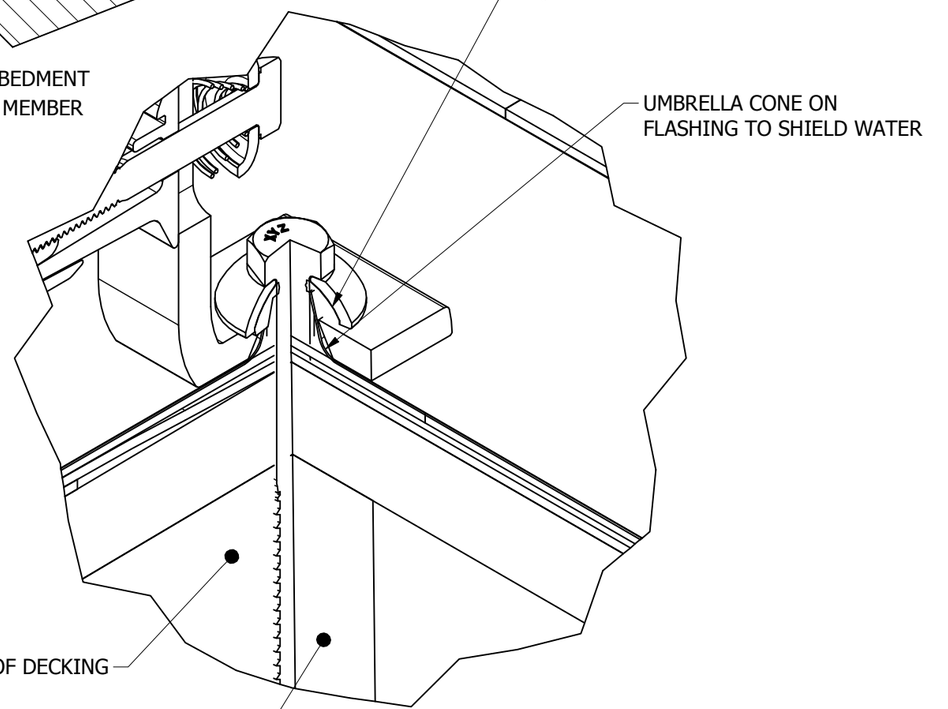
BIN: 8

REVISION:

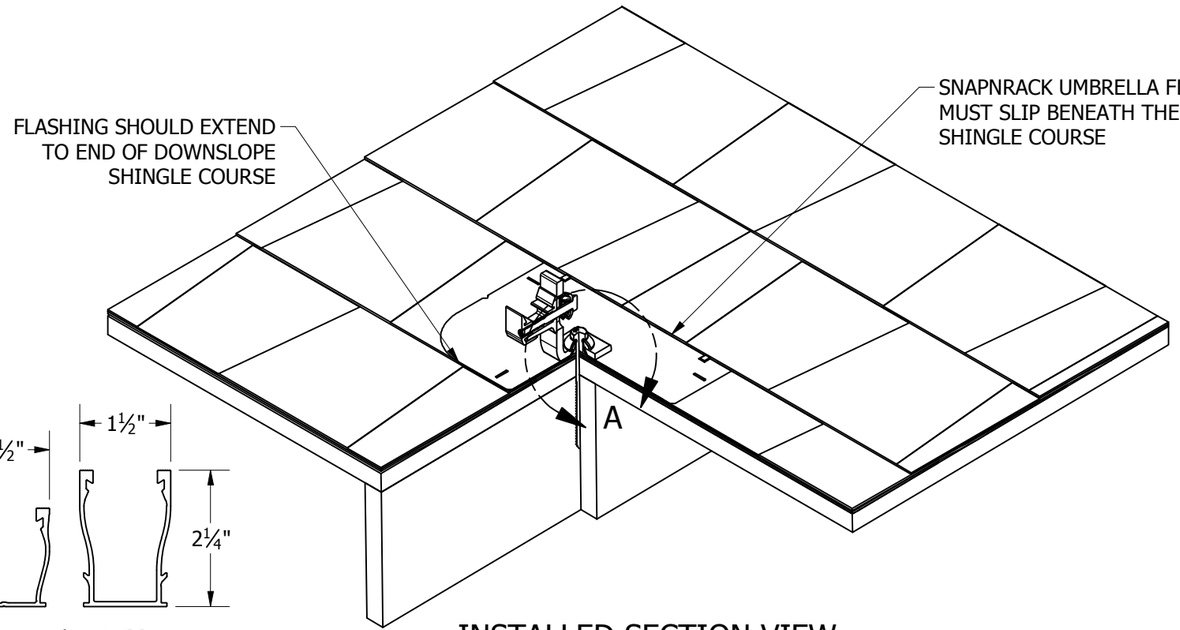
| | | | |
|---|---|---|---|
| 1 | 5/7/2019 | NEW DETAIL | MJA |
| 1 | 6/18/2019 | DRO-00138 | MJA |



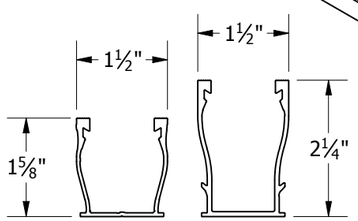

PENETRATION DETAIL




DETAIL A




INSTALLED SECTION VIEW




UR-40 RAIL | UR-60 RAIL
FOR USE WITH SNAPNRACK ULTRA SERIES RAILS

SnapNrack™ Solar Mounting Solutions

Sunrun South LLC
595 MARKET STREET, 29TH FLOOR • SAN FRANCISCO, CA 94105 USA
PHONE (415) 580-6900 • FAX (415) 580-6902



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|---|---|---|---|---|---|
| DESIGNER: M.AFFENTRANGER | SCALE: DNS | DRAWING NUMBER: SNR-DC-00339 | DESCRIPTION: ULTRA RAIL, ATTACHMENT DETAIL, UMBRELLA L FOOT TO RAFTER | REV: 1 |
| DRAFTER: M.AFFENTRANGER | | | | |
| APPROVED BY: B.PETERSON | DATE: 6/18/2019 | | | |