Company Code____________

next generation energy.

Photovoltaic System Quote

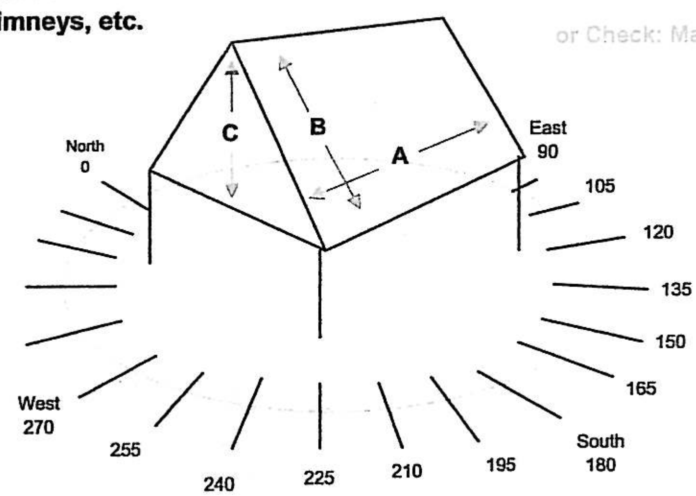
*ALL FIELDS REQUIRED

CLIENT INFO	
Company:	Phone:
Main Contact:	Cell Phone:
Last Name:	Email:
First Name:	
Billing Address:	
City/State:	Zip Code:
Materials ONLY Quote:	
Materials PLUS INSTALL	
Project Address:	
City/State:	Zip Code:
Design Services Needed ($300 min.):	
Certified Dealer:	

- **Mark Location of vents, chimneys, etc.**

Indicate Desired System Size________kW

or Check: Max Possible____



Dimensions:

A:__________

B:__________

C:__________

Residential:_____

Commercial:_____

MOUNTING INFO

*Roof Mounting:

Roof Orientation (magnetic south = 180):___________

Type of Roof: Asphalt_____ Tile_____ Flat Tile_____ Tar & Gravel_____ Other_____

Pitch of Roof: _____Normal—easily walked over (18-20 degree slope)

_____Steep—cannot be safely walked on

_____Low—less than 18 degrees

_____Flat—very slight to no apparent pitch

OR

Pitch of Roof (rise/run): flat roof_____ 1/12(flat)_____ 2/12_____ 3/12_____ 4/12_____ 5/12_____

6/12_____ 7/12_____ 8/12_____ 9/12_____ 10/12_____ 11/12_____ 12/12_____ (steep)

Flat Roof Only: Type of Attachment: Mechanical______ Ballast______

Roof Age:__________ Rafter Spacing:12"____14"____16"____19.2"____ 24"____48"____

Rafter Material: Wood_____ Metal_____

Roof Condition: Good_____ Fair_____ Poor_____

Snow Load Zone:_______________ Wind Load Zone:________________

Please note any shading issues from nearby trees, poles, or other

structures:____

Number of Stories:

Single_____ Two Story_____

Other_____ Please Explain____

Construction Phase: New_____ Existing_____ Framed_____ Drywalled_____

*Ground Mounting:

Distance from Building:____________

Other describing features that could affect the job: *(shading, swamp cooler, sky lights, trees, slope, soil conditions, terrain, etc.)*

System Information

Main Panel Location:______________________________

Additional Space on Panel:______________________________________

Main Panel Rating (amps):___________________________________

Buss Rating (amps):___________________________________

Sub Panel Location:___________________________________

Desired Inverter Location:______________________________________

System Description *(specific panels desired? Specific inverter desired? Possible added costs?)*:

____

____

____

CUSTOM MOUNTING *(awnings/shade structure, parking structure)*:__________________

____

____

____

Payment Information

Down payment: $__________________ CK#__________________ Installer____

Date____/____/__________________

Complete Cert _________________________________FPL: $ ______________________

Other____

Dealer _________________________________ Sales Rep____

Explanation of charges

____

____

____

____

____

____

____

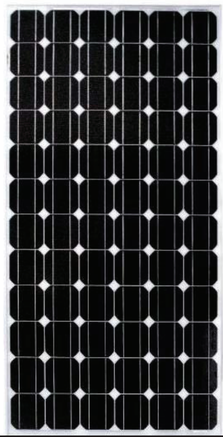
PV System Field Inspection Checklist

Array Installation and Wiring	
Proper insulation on module wiring (USE-2)	
Proper connectors on array wiring extensions	
Proper grounding of array & array mount	
Grounded conductors installed per 690.4(C)	
Array mount properly secured and sealed	
Suitable transition from open wiring to enclosed wiring	
Metallic conduit through attics to array disc	
DC Connections	
Source Circuit Combiner Boxes	
DC-rated circuit breakers or fuses with adequate voltage rating	
Listed equipment	
DC Component Enclosures	
Proper conductor sizes and insulation types	
Proper conductor terminations	
DC ratings on DC components	
Listed equipment	
SINGLE POINT GROUNDING!	
Optional grounding electrode conductor	
Charge Controllers (Battery backup systems only)	
Input and output disconnects labeled	
Listed charge controller	
Proper wire sizes (In #8 or #6, out #6 or #4)	
Grounded	
Inverters (DC side)	
Input and output disconnects labeled	
Listed	
Proper wire sizes (Usually 2/0, but sized to disconnect for battery backup. Smaller for straight grid-connect)	
Grounded	
Batteries (Battery backup systems only)	
Terminals protected from shorting	
Cables properly terminated (no set screw lugs on fine stranded wire)	
Maintenance-free vented for cooling	
Flooded vented to outside	
Labeled with proper safety procedures	
AC Connections	
Inverters	
Proper wire sizes (usually #6 for battery backup, smaller for straight GC)	

AC Component Enclosure	
Isolated Neutral busbar	
Listed components	
Labeled disconnects and C/B	
Standby Circuits (Battery backup only)	
Watch for multiwire if 120V	
Labeled	
Utility Disconnect (Not required by NEC, maybe by utility)	
Labeled per NEC690.56	
Visible, lockable, accessible, load break, external handle	
Point of Utility Connection	
Labeled per NEC690.56	
Complies with NEC690.64 (especially (B)(2))	
NEC690.64(B)(5) exempts bolt-on requirement	
Building Main Disconnect	
Labeled per NEC690.54	
Does the System Work? (Not required by NEC, but owners appreciate it)	
Observe currents, voltages and powers as displayed	

SDM-170/X-72M

Mechanic Data	
Cells:	Mono-crystalline 125×125mm（5″）
No.of cells:	72Pcs（6×12）
Dimensions	1580（L）×808(W)×35(H)mm
Weight:	33 Lbs
Front Glass:	3.2mm Tempered glass
EVA:	EVA
Backsheet:	TPT/TPE
Frame:	Anodized aluminum alloy
Junction Box:	IP65 Rated With bypass diodes
Cable:	900mm/900mm(Φ4mm²)
Connection:	Same as MC Plug Type

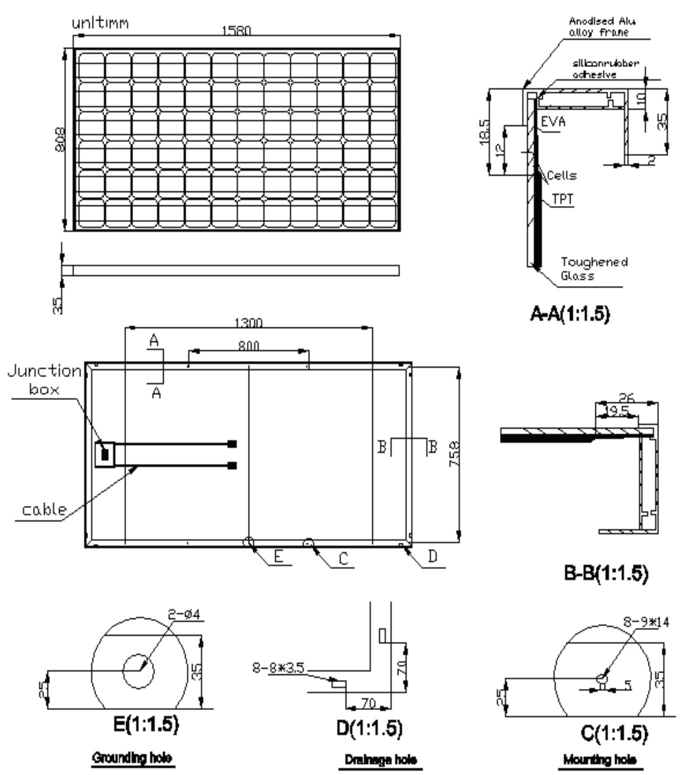


ELECTRICAL DATA								
Pmax(±3%)	155W	160W	165W	170W	175W	180W	185W	190W
Vmp	34.6V	34.9V	35.6V	35.8V	36.2V	36.8V	37.5V	37.7V
Imp	4.48A	4.60A	4.65A	4.76A	4.85A	4.90A	4.95A	5.04A
Voc	44.0V	44.3V	44.4V	44.5V	44.7V	44.8V	44.9V	45.1V
Isc	5.0A	5.05A	5.10A	5.15A	5.20A	5.25A	5.30A	5.35A
Max system voltage	DC1000V(TUV) DC600V(UL)							
STC	Standard test conditions: irradiance: 1000W/ m² AM: 1.5 temperature: 25□							

Guaranteed Module Output - 180W DC

Temperature coefficients	
Nominal Operating Cell Temperature（NOCT）	45 ±2
Temperature Coefficient of ISC (α)	0.038%/
Temperature Coefficient of VOC (β)	-0.34%/
Temperature Coefficient of Pmax	-0.48%/

Permissible Operating Conditions	
Operating temperature:	-40□ to +85□
Maximum Hail diameter @ 80Km/h:	up to 25mm
Maximum loading capacity:	200Kg/m² (2400Pa)
Continuous wind pressure:	130Km/h (60M/S)



Features and benefits

1. High-efficient solar cells construction.
2. Nominal 24 V DC for standard output
3. Nonleaded and tin-coated ribbon and washing-free soldering flux.
4. High transmissivity low-iron 3.2mm tempered glass
5. Light anodized aluminum frame
   ensure that problems of water freezing and warping do not occur.
6. TUV / UL certified junction box
7. Cross-linking rate above 80%
8. Automatic lamination technology
9. 25 year power output warranty

ecoSolargy inc.

Distributed by: Eco-$mart, Inc. (888) 329-2705 ph / (941) 377-9460 fx / info@eco-smart.com

QIGU.E330315
Photovoltaic Modules and Panels

Page Bottom

Photovoltaic Modules and Panels

See General Information for Photovoltaic Modules and Panels

ECOSOLARGY INC E330315
SUITE 116
1370 REYNOLDS AVE
IRVINE, CA 92614 USA

Photovoltaic modules, Models SDM-170/(150)-72M, SDM-170/(155)-72M, SDM-170/(160)-72M, SDM-170/(165)-72M, SDM-170/(170)-72M, SDM-170/(175)-72M, SDM-170/(180)-72M, SDM-170/(185)-72M.

Last Updated on 2009-06-03

Questions? Notice of Disclaimer Page Top

Technical Data

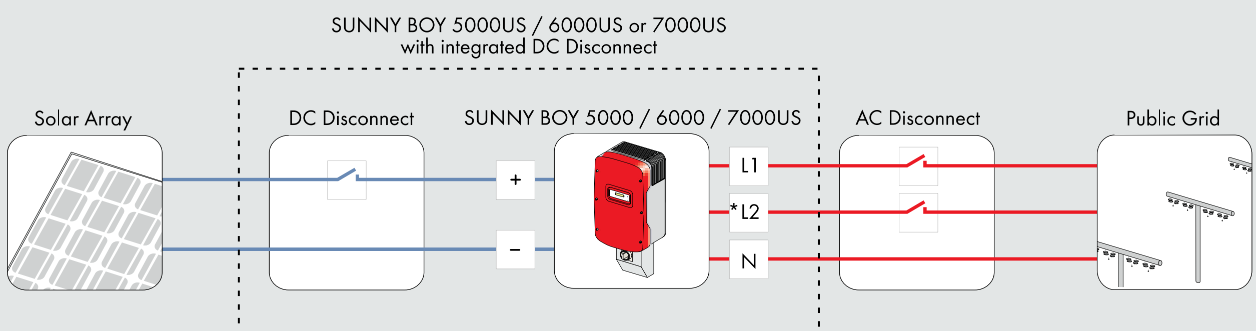
- 96 % CEC weighted efficiency
- 10-year standard warranty
- Certified to the new UL 1741/ IEEE 1547
- Integrated load-break rated DC disconnect switch
- Integrated fused series string combiner
- Sealed electronics enclosure and OptiCool
- Comprehensive SMA communications and data collection options
- Ideal for residential or commercial applications
- Rugged cast aluminum outdoor rated enclosure

	Sunny Boy 5000US	Sunny Boy 6000US	Sunny Boy 7000US
Input Data (DC)			
Recommended Max. PV Power (Module STC)	6250 W	7500 W	8750 W
Max. DC Voltage	600 V	600 V	600 V
Peak Power Tracking Voltage	250 – 480 V	250 – 480 V	250 – 480 V
DC Max. Input Current	21 A	25 A	30 A
Number of Fused String Inputs	3 (inverter), 4 x 15 A (DC disconnect)	3 (inverter), 4 x 15 A (DC disconnect)	3 (inverter), 4 x 15 A (DC disconnect)
PV Start Voltage (adjustable)	300 V	300 V	300 V
Output Data (AC)			
AC Nominal Power	5000 W	6000 W	7000 W
AC Maximum Output Power	5000 W	6000 W	7000 W
AC Maximum Output Current (@ 208, 240, 277 V)	24 A, 21 A, 18 A	29 A, 25 A, 22 A	34 A, 29 A, 25 A
AC Nominal Voltage / Range	183 – 229 V @ 208 V 211 – 264 V @ 240 V 244 – 305 V @ 277 V	183 – 229 V @ 208 V 211 – 264 V @ 240 V 244 – 305 V @ 277 V	183 – 229 V @ 208 V 211 – 264 V @ 240 V 244 – 305 V @ 277 V
AC Frequency / Range	60 Hz / 59.3 – 60.5 Hz	60 Hz / 59.3 – 60.5 Hz	60 Hz / 59.3 – 60.5 Hz
Power Factor	0.99 @ nominal power	0.99 @ nominal power	0.99 @ nominal power
Efficiency			
Peak Inverter Efficiency	96.8 %	97.0 %	97.1 %
CEC Weighted Efficiency	95.5 %	95.5 %/95.5 %/96.0 %	95.5 %/96.0 %/96.0 %
General Information			
Dimensions W x H x D in inches	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5
Weight / Shipping Weight	141 lbs / 148 lbs	141 lbs / 148 lbs	141 lbs / 148 lbs
Ambient Temperature Range	-13 to +113 °F	-13 to +113 °F	-13 to +113 °F
Power Consumption: standby / nighttime	< 7 W / 0.1 W	< 7 W / 0.1 W	< 7 W / 0.1 W
Topology	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave
Cooling Concept	OptiCool, forced active cooling	OptiCool, forced active cooling	OptiCool, forced active cooling
Mounting Location In-/Outdoor (NEMA 3R)	●/●	●/●	●/●
Features			
LCD Display	●	●	●
Lid Color: aluminum/red/blue/yellow	●/❍/❍/❍	●/❍/❍/❍	●/❍/❍/❍
Communication: RS485 / Wireless	❍/❍	❍/❍	❍/❍
Warranty: 10-year	●	●	●
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	●	●	●

Specifications for nominal conditions: ● Included ❍ Optional

SUNNY BOY 5000US / 6000US / 7000US

The Sunny Boy 5000US, 6000US and 7000US represent our larger units in the new "US" series of Sunny Boy string inverters. They are extremely robust inverters equally suited for large residential or commercial applications. Completely updated with our most advanced technology, they were designed specifically to meet the new IEEE 1547 requirements. The larger inverters of the new US series come with an integrated DC disconnect switch making installation even more cost-effective. They can even be configured for positive ground systems in the field making them more versatile than ever. Increased efficiency means better overall performance and shorter payback periods. The Sunny Boy 6000US and 7000US are compatible for use with the Sunny Tower 36 kW and 42 kW systems. Each comes with a standard ten year warranty and is engineered and built to provide years of trouble-free service.



*Not for 277 V

- 96 % CEC weighted efficiency
- 10-year standard warranty
- Certified to the new UL 1741/ IEEE 1547
- Integrated load-break rated DC disconnect switch
- Integrated fused series string combiner
- Sealed electronics enclosure and OptiCool
- Comprehensive SMA communications and data collection options
- Ideal for residential or light commercial applications
- Rugged cast aluminum outdoor rated enclosure

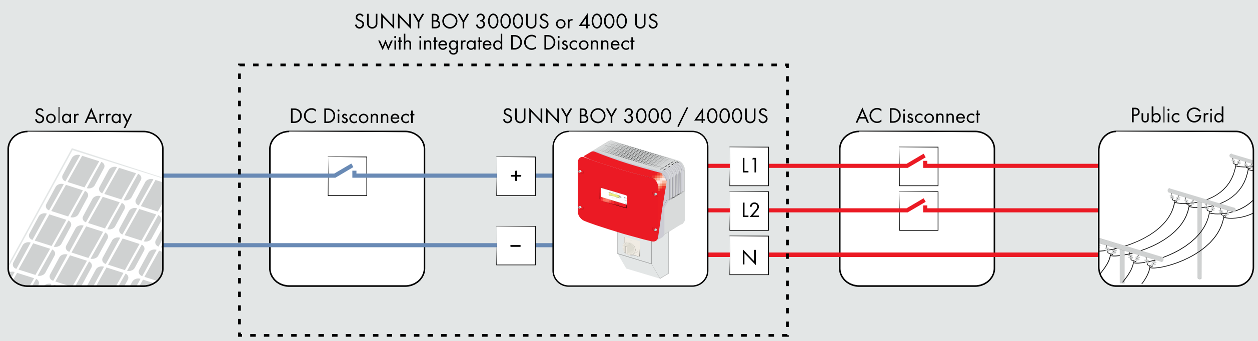
Technical Data

	Sunny Boy 3000US	Sunny Boy 4000US
Input Data (DC)		
Recommended Max. PV Power (Module STC)	3750 W	4375 W @ 208 V / 5000 W @ 240 V
Max. DC Voltage	500 V	600 V
Peak Power Tracking Voltage	175 V – 400 V @ 208 V 200 V – 400 V @ 240 V	220 V – 480 V @ 208 V 250 V – 480 V @ 240 V
DC Max. Input Current	17 A	18 A
Number of Fused String Inputs	2 (inverter), 4 x 15 A (DC disconnect)	2 (inverter), 4 x 15 A (DC disconnect)
PV Start Voltage (adjustable)	228 V	285 V
Output Data (AC)		
AC Nominal Power	3000 W	3500 W @ 208 V / 4000 W @ 240 V
AC Maximum Output Power	3000 W	3500 W @ 208 V / 4000 W @ 240 V
AC Maximum Output Current	15 A @ 208 V, 13 A @ 240 V	17 A
AC Nominal Voltage / Range	183 – 229 V @ 208 V 211 – 264 V @ 240 V	183 – 229 V @ 208 V 211 – 264 V @ 240 V
AC Frequency / Range	60 Hz / 59.3 Hz – 60.5 Hz	60 Hz / 59.3 Hz – 60.5 Hz
Power Factor	0.99 @ nominal power	0.99 @ nominal power
Efficiency		
Peak Inverter Efficiency	96.5 %	96.8 %
CEC Weighted Efficiency	95.0 % @ 208 V / 95.5 % @ 240 V	95.5 % @ 208 V / 96.0 % @ 240 V
General Information		
Dimensions W x H x D in inches	17.8 x 13.8 x 9.3	17.8 x 13.8 x 9.3
Weight / Shipping Weight	84 lbs / 97 lbs	84 lbs / 97 lbs
Ambient Temperature Range	–13 to +113 °F	–13 to +113 °F
Power Consumption: standby / nighttime	< 7 W / 0.1 W	< 7 W / 0.1 W
Topology	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave
Cooling Concept	OptiCool, forced active cooling	OptiCool, forced active cooling
Mounting Location Indoor / Outdoor (NEMA 3R)	●/●	●/●
Features		
LCD Display	●	●
Lid Color: aluminum/red/blue/yellow	●/❍/❍/❍	●/❍/❍/❍
Communication: RS485 / Wireless	❍/❍	❍/❍
Warranty: 10-year	●	●
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	●	●

Specifications for nominal conditions: ● Included ❍ Optional

SUNNY BOY 3000US / 4000US

The Sunny Boy 3000US and 4000US are the first of the new "US" series of Sunny Boy string inverters. They have been updated with our most advanced technology and are designed specifically to meet the new IEEE 1547 requirements. Their compact design makes them ideal for light commercial or residential use and the integrated DC disconnect makes installation more cost-effective. They are field configurable for positive ground systems making them more versatile than ever. Increased efficiency means better overall performance and shorter payback periods. Each are engineered and built to last and now come with a standard ten-year warranty. Sunny Boy inverters are trusted worldwide to go the distance.



Mounting & Racking System Catalog

Next Generation Energy® has combined NEX® Tube with the patent pending, tremendous Zilla™ system to make racking so simple it's scary. The capabilities of this new system are outstanding. There has never been a more dynamic, omni-laterally strong racking system available. Supporting all solar panel modules and products, Zilla™ has been engineered with versatility and simplicity in mind. Using less total material, it allows for a finer, stronger product exhibiting the highest standard of craftsmanship. Our attractive new design is an asset to any solar system.

Zilla™ is made with recycled aluminum and is 100% recyclable.

next generation energy®

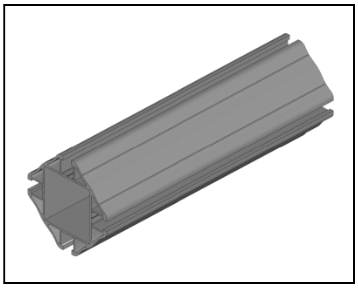
It's in the Sun!™

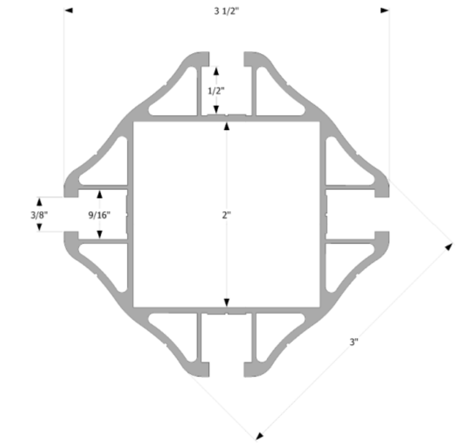
www.zillarac.com

Zilla™ Rac

The superiority of design allows compatibility with any racking and standoff components. Every type of solar system installation is made simple with Zilla™, and therefore costs are cut down significantly. We have focused on the strength, durability, and outstanding engineering, in order to deliver the best racking system possible. In conjunction with the Zilla™ Flashing mounting system, this rack allows for a near flush mounting at any angle with unlimited options. Zilla™ Rac is also perfectly integrated with NEX®, which provides a hybrid solution with superior strength.

Zilla™ Rac 3.5





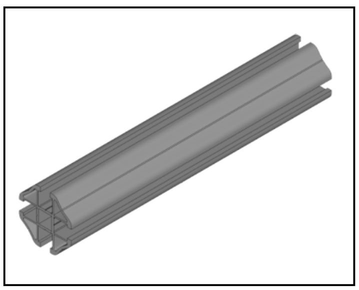
ZR-3.5

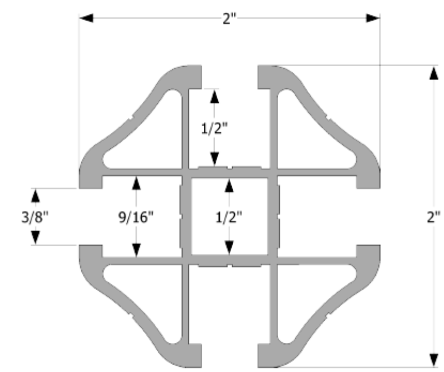
3.5" Diameter

The 3.5 series was designed to hold the heaviest of loads, while still providing the largest variety of applications.

Product	Material	Size	Color	#/ pkg
ZR-3.5	6005 T5 aluminum alloy	3.5"x19'	Clear	4
ZR-3.5BLK			Black	

Zilla™ Rac 2.0





ZR-2.0

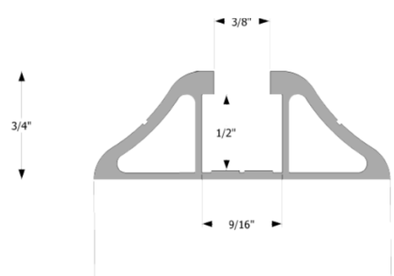
2.0" Diameter

The 2.0 series was designed to hold the medium of loads, and also provide the largest variety of applications possible.

Product	Material	Size	Color	#/ pkg
ZR-2.0	6005 T5 aluminum alloy	2"x19'	Clear	4
ZR-2.0BLK			Black	

Note: All Nex® and Zilla™ Products are 100% compatible with all sizes of Zilla™ Rac and Zilla™ Grip

Zilla™ Grip

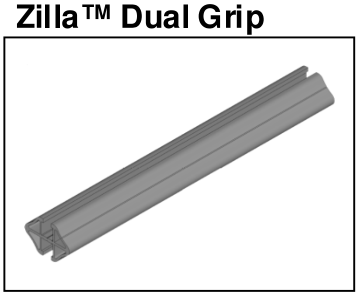


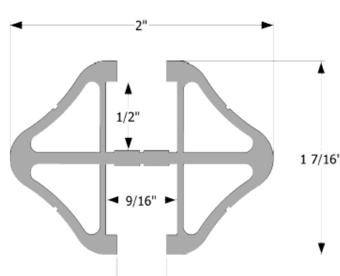
ZG-2.0

The Zilla™ Grip was designed to hold light loads but it is still able to be used in many different ways.

Product	Material	Size	Color	#/ pkg
ZG-2.0	6005 T5 aluminum alloy	2"x8' 2"x10' 2"x12'	Clear	4
ZG-2.0BLK			Black	

Zilla™ Dual Grip





ZGD-2.0

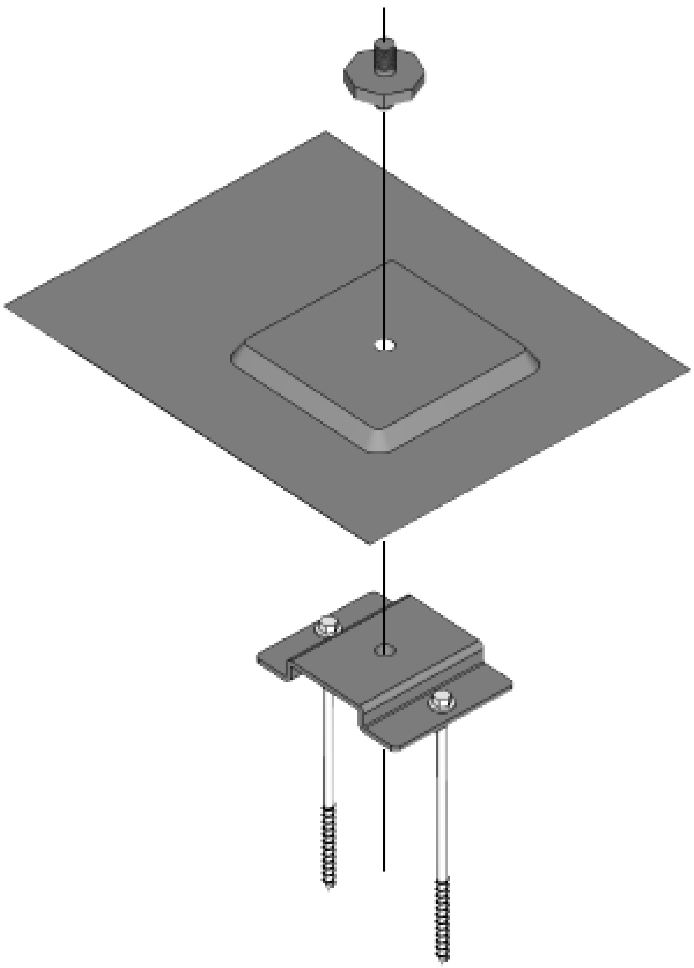
The Zilla™ Dual Grip was designed to hold light loads just like the Grip, except pieces can be attached on both sides of it.

Product	Material	Size	Color	#/ pkg
ZGD-2.0	6005 T5 aluminum alloy	2"x8' 2"x10' 2"x12'	Clear	4
ZGD-2.0BLK			Black	

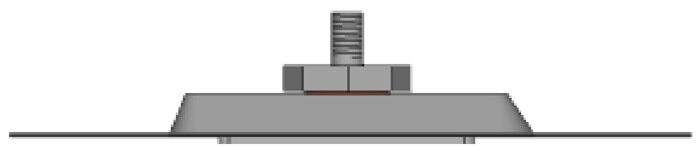
Zilla™ Flashing Assembly

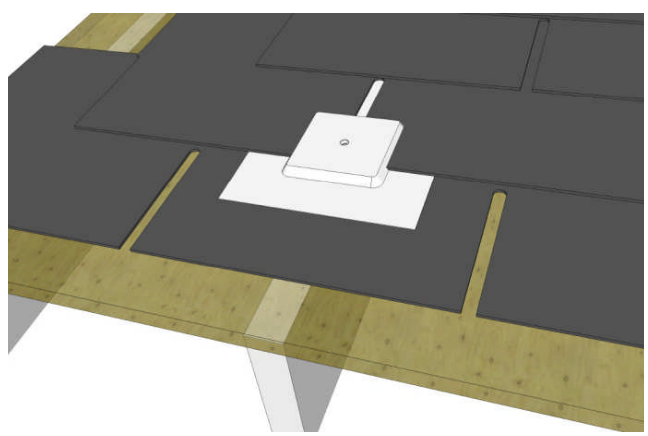
Zilla™ Flashing is a multi component racking system that incorporates a complete flashing system, adjustable standoffs and other mounting hardware options, in order for it to outlast your solar system. Simple installation & less material used cuts the costs of traditional racking systems significantly. It uses either Zilla™ or standard hardware in order to mount flush, roof, ground, pole, awning and other special applications. The Zilla™ Flashing is also completely integrated with NEX® Tube racking and components.

Zilla™ Flashing is the best flashing assembly available on the market. Zilla™ can be used with any available standoff and components. The longevity of this product is outstanding, outlasting the roof and your solar system due to the innovative design that protects all of the components from environmental factors.



The Zilla™ Flashing Assembly is sold as 4 piece assembly. This assembly includes: double stud bolt, silicone washer, flashing, and base plate. However, we also sell the double studded bolts and washers separately.





SB/SC COMBINER BOXES

> Greatly simplifies input and output wiring

> Available in 6 to 52 circuit configurations

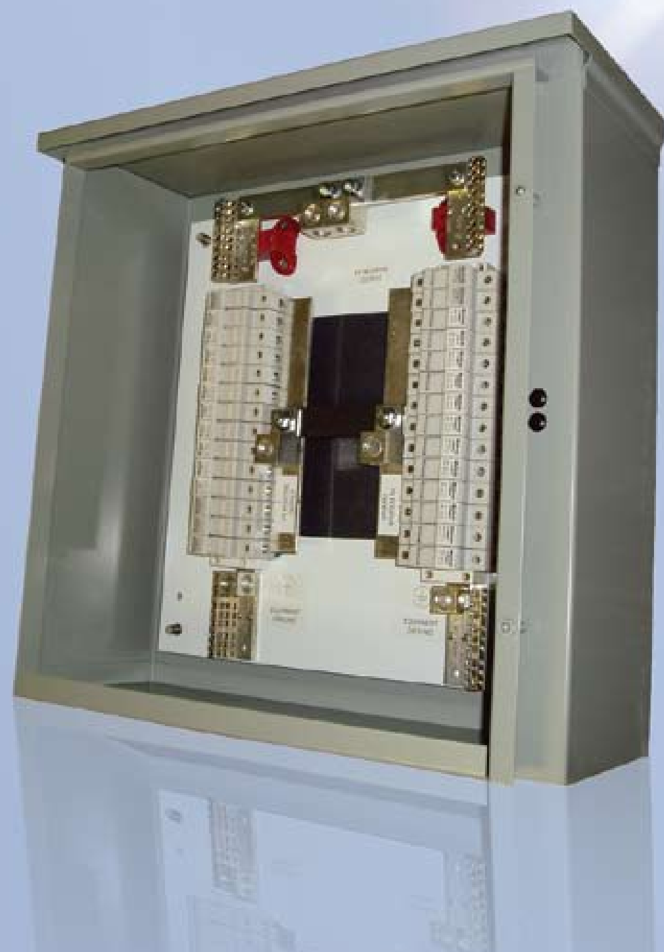
> Compact, rugged low cost design

> Reliable bus-work for efficient high current conductor combining

> PV positive wires all land directly on Touch Safe™ fuse holders

> Sturdy NEMA 3R/4 wall mount steel enclosure

> ETL listed to UL 1741



SB/SC COMBINER BOXES

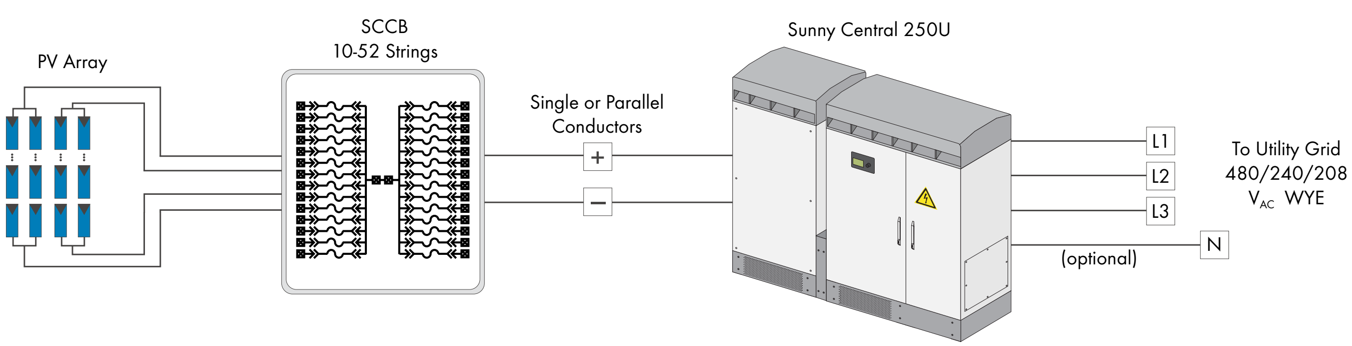
Simplify wiring for added convenience and safety

SMA America's SB/SC Combiner Boxes are available in sizes ranging from 6 to 52 PV inputs to provide greater flexability and expandability in system design. Oversized bus-work adds high efficiency and dependability where it's needed most. The large NEMA 3R/4 enclosure provides ample room for conductors which reduces installation time. Designed with installers in mind, we know you'll find the SB/SC Combiner Boxes a welcome addition to our great line of inverter products.

Technical Data
SB/SC COMBINER BOX

	SBCB-6 (Sunny Boy)	SCCB-12 (Sunny Central)	SCCB-28 (Sunny Central)	SCCB-52 (Sunny Central)
Number of Inputs (Positive & Negative)	6	12	28	52
Positive Input Wire Size	10 to 6 AWG	10 to 6 AWG	10 to 6 AWG	10 to 6 AWG
Positive Input Terminal Torque	14 in-lb.	14 in-lb.	14 in-lb.	14 in-lb.
Negative Input Wire Size	10 to 6 AWG	10 to 6 AWG	10 to 6 AWG	10 to 6 AWG
Negative Input Terminal Torque	35 in-lb.	35 in-lb.	35 in-lb.	35 in-lb.
Output Wire Size	6 to 350 AWG	6 to 350 AWG	6 to 350 AWG	6 AWG to 300 MCM
Output Terminal Torque	350 in-lb.	350 in-lb.	350 in-lb.	350 in-lb.
Max. Input Fuse Rating (Midget)	15 A, 600 V_{DC}	20 A, 600 V_{DC}	15 A, 600 V_{DC}	8 A, 600 V_{DC}
Max. Output Current	90 A_{DC}	240 A_{DC}	420 A_{DC}	416 A_{DC}
Max. Continuous Output Current	72 A_{DC}	192 A_{DC}	336 A_{DC}	333 A_{DC}
Max. Number of Output Wires	1 Pos, 1 Neg	1 Pos, 1 Neg	2 Pos, 2 Neg	2 Pos, 2 Neg
PV Array Configuration	Negative Grounded*	Negative Grounded*	Negative Grounded*	Negative Grounded*
Enclosure Type	NEMA 3R, Steel	NEMA 3R/4, Steel	NEMA 3R/4, Steel	NEMA3R/4, Steel
Weight (Approximate)	11 lbs	48 lbs	56 lbs	70 lbs
Dimensions W x H x D in inches	8 x 10 x 6	16 x 16 x 6	20 x 20 x 8	30 x 42 x 8

Other sizes and designs available upon request.
*Fusing available on positive or negative input, specify when ordering



SMA's line of SB and SC Combiner Boxes is a culmination of many years of experience with the difficulties of combining large numbers of PV strings. This simple component has generally become known as a common point of failure in large PV arrays. The SMA design minimizes the number of components, resulting in the most robust, easy to install, low cost and reliable combiner boxes in the PV industry. PV wires are landed directly to individual Touch Safe™ fuse holders. The fuse holder outputs are combined into heavy-duty bus-bar combs where the output wires are connected to over-sized mechanical lugs. All wiring is routed in an orderly manner through the enclosure, minimizing the chance of shorting caused by pinched or abraded wires. Individual PV string circuit fuses may be safely de-energized and removed by opening the Touch Safe™ fuse holders. No special tools are required. Output wires may be paralleled, keeping wire sizes small and easy to pull through conduit. Combiner boxes may be paralleled to increase the total number of PV strings. The steel enclosure is rated for outdoor installations and all SMA combiner boxes are ETL listed to UL 1741. Please call for availability of models not listed in the chart above or for special order configurations.

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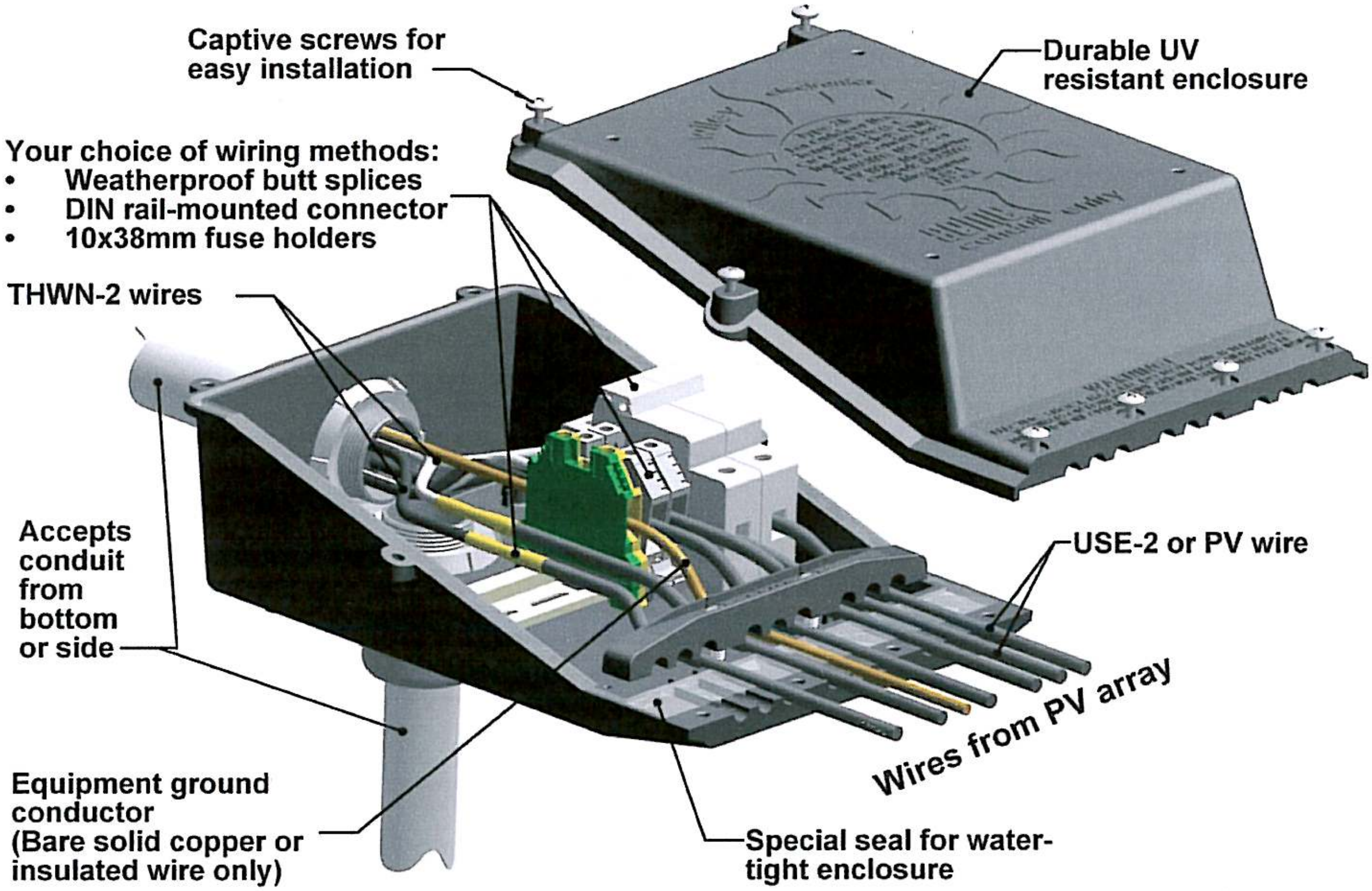
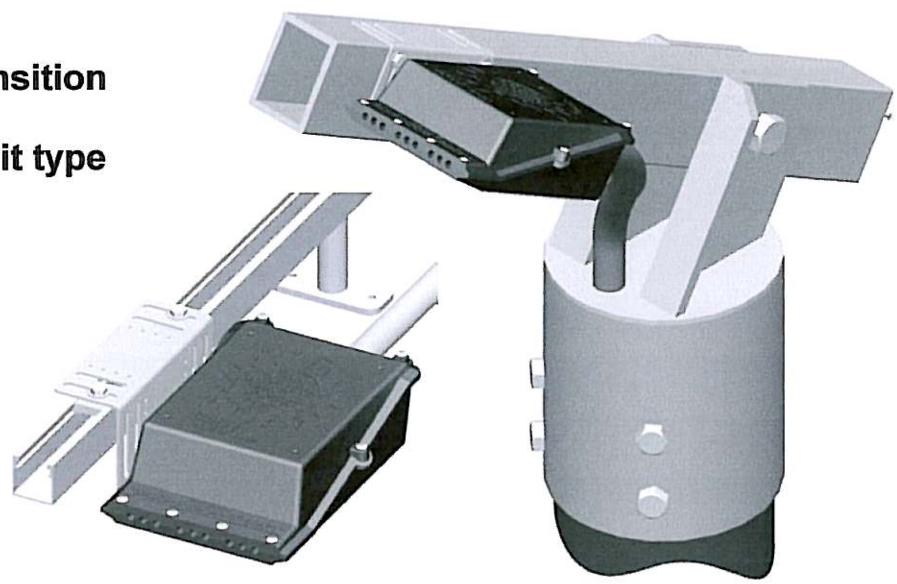


- **Simple array to conduit transition**
- **Compatible with any conduit type**
- **Protective enclosure for connecting USE-2 or PV wire to THWN-2 wires**
- **Two-piece enclosure for unobstructed wiring**
- **NEMA 3R rated for outdoor use**



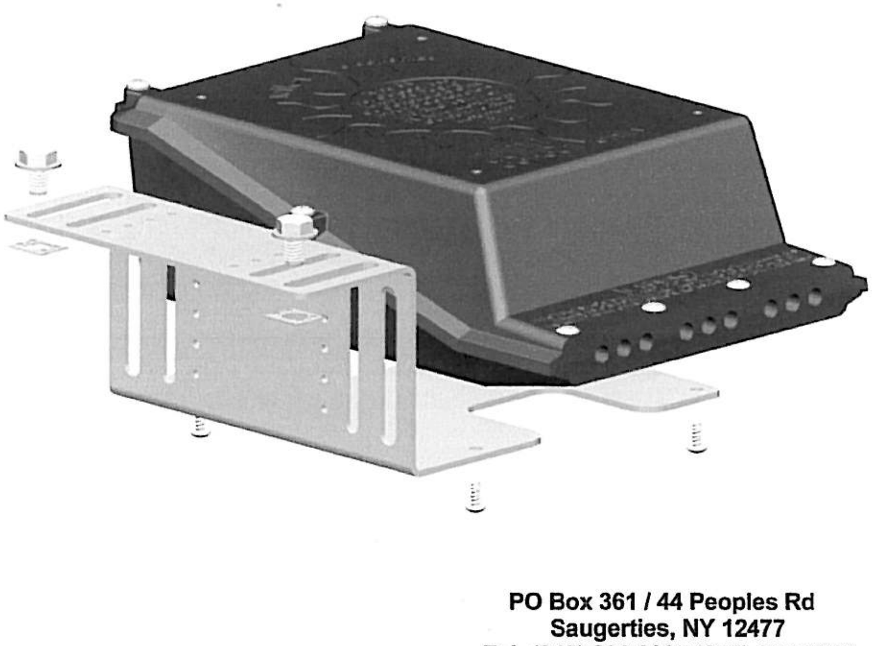
Specifications

Input Wire Diameter Range	5.0 - 6.8mm [0.20 - 0.27in] (10-12AWG USE-2/PV Wire)
Maximum number of input conductor slots	9
Maximum number of PV strings	4
Maximum number of combined strings	4
Equipment Ground Conductor Type	Bare solid or jacketed only
Equipment Ground Conductor Diameter range	4.0 - 6.8mm [0.16 - 0.27in]
Acceptable Conduit sizes	19.05mm, 25.4mm [0.75in, 1.0in]
Internal Volume	1840cm^3 [112in^3]
Internal Height	72.0mm [2.83in]
Knockouts	Side, Bottom

Configurations

ACE Part Number	ACE Configuration	Terminal Block	Terminal Block Internal Bus	Fuse Holder	Fuse Combiner Bus	Grounding Terminal	DIN Rail
ACE-PT	Pass-Through using Butt Splices/Wire Nuts	N/A	N/A	N/A	N/A	N/A	N/A
ACE-1P	1-String Pass-through	2	N/A	N/A	N/A	1	1
ACE-2P	2-String Pass-through	4	N/A	N/A	N/A	1	1
ACE-3P	3-String Pass-through	6	N/A	N/A	N/A	1	1
ACE-4P	4-String Pass-through	8	N/A	N/A	N/A	1	1
ACE-2C	2-Strings Combiner	4	2X 2-Pole	Not required for 2-string combiner	N/A	1	1
ACE-3C	3-Strings Combiner	3	1X 3-Pole	3	1X 3-Pole	1	1
ACE-4C	4-Strings Combiner	4	1X 4-Pole	4	1X 4-Pole	1	1

ACE Mounting Bracket



Made of lightweight, corrosion resistant anodized aluminum. Available in Black or Clear Anodize.

Mounting Bracket Assembly Includes:
- 1X ACE Mounting Bracket
- 4X Mounting Screws
- 2X Bonding Washers

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Website: www.we-llc.com

~acme pv peripherals~

Fuse Sizing

Fuses are used for overcurrent protection to prevent fire or damage to equipment. Selecting the appropriate size fuse for the circuit will allow current passage during normal operation and quick interruption during a short circuit or overload condition. Sizing a fuse that is too small will interrupt current passage during normal operation, while sizing a fuse that is too large will not provide protecting to the circuit during a short or overload condition. For PV systems, sizing of fuses are determined by the electrical rating of PV modules and the National Electric Code (NEC) requirements. Consult your PV module manufacturer to determine the appropriate size fuse.

Warning

- **Never open a fuse holder when it is under load. Arcing will occur causing damage to fuse holder. Always disconnect from the load before opening fuse holder.**
- **Wiring must have sufficient ampacity for the selected fuse. Size wires according to NEC requirements.**

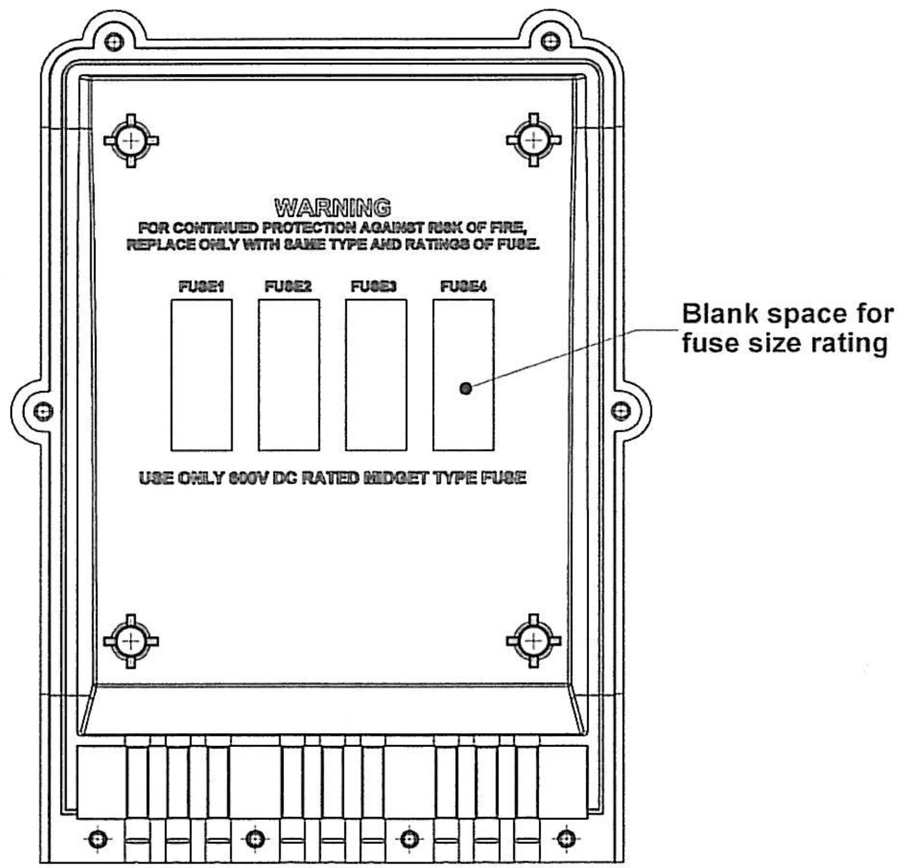

Figure 18: ACE Fuse Rating Location

Mark the fuse size in blank space provided using permanent white marker.

Specifications

Maximum Input Voltage	600V DC
Maximum Input Current	64A DC Continuous
Maximum Input Short Circuit Current	51A DC
Input Wire Diameter Range	5.0 - 6.8mm [0.20 - 0.27in] #10-12AWG USE-2/PV Wire
Maximum number of input conductor slots	9
Maximum number of PV strings	4
Maximum number of combined strings	4
Equipment Ground Conductor Diameter range	4.0 - 6.8mm [0.16 - 0.27in]
Acceptable Conduit sizes	19.05mm, 25.4mm [0.75in, 1.0in]
Internal Volume	$1840cm^3$ [$112in^3$]
Knockouts	Side and Bottom, 3/4" and 1"
Minimum Fuse Holder Tightening Torque	2.5 N-m [22 in-lb] for #18-8 AWG wires
Minimum Combiner Bus Tightening Torque	4.0 N-m [35 in-lb] for #14-6 AWG wires
Minimum Terminal Block Tightening Torque	2.0 N-m [18 in-lb] for #14-6 AWG wires
Minimum Grounding Terminal Tightening Torque	3.0 N-m [26 in-lb] for #10-6 AWG wires
Fuse Holder Wire Strip Length	12mm [0.47in]
Combiner Bus Terminal Wire Strip Length	12mm [0.47in]
Terminal Block Wire Strip Length	10mm [0.39in]
Grounding Terminal Wire Strip Length	14mm [0.55in]
Fuse Type	Midget 10 X 38mm, 600V DC

<u>Table 3: Specifications</u>

- Pass-through with DIN rail-mount terminals (1-4 strings)

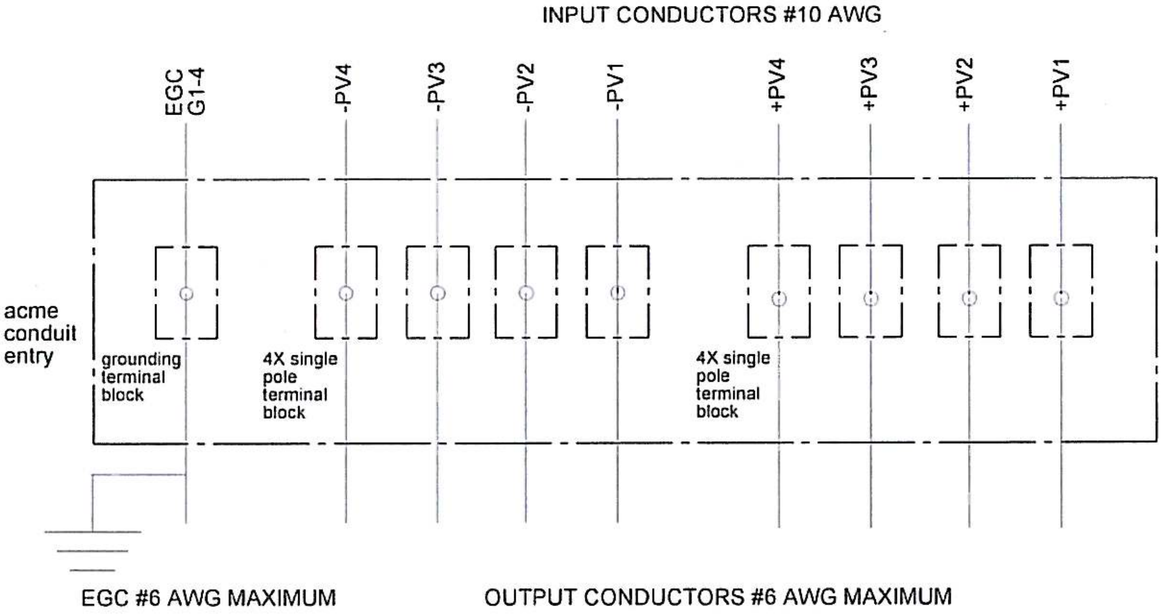

Figure 10: Wiring Diagram – Pass-Through with DIN Rail-Mount Terminals

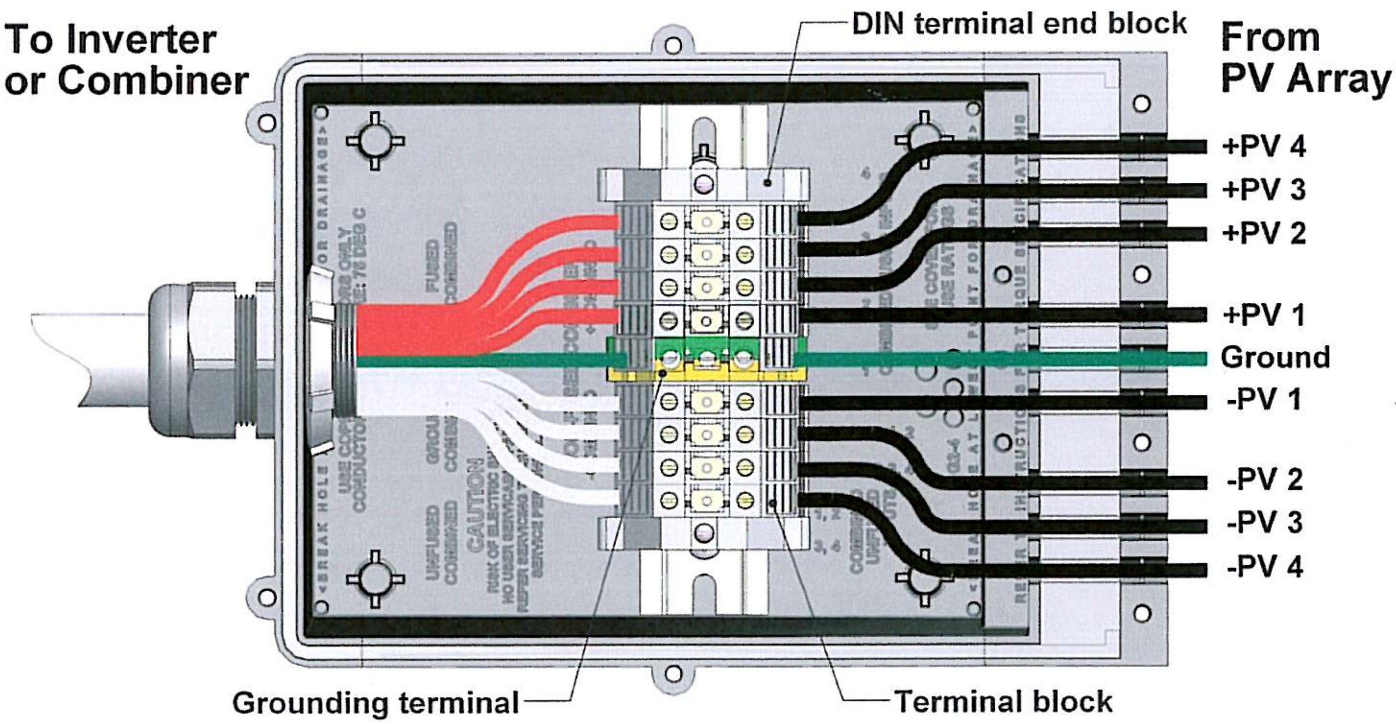

Figure 11: Wiring Layout – Pass-Through with DIN Rail-Mount Terminals

String Combiner

- Fused combiner with DIN rail-mount components, negative ground (3 or 4 strings)

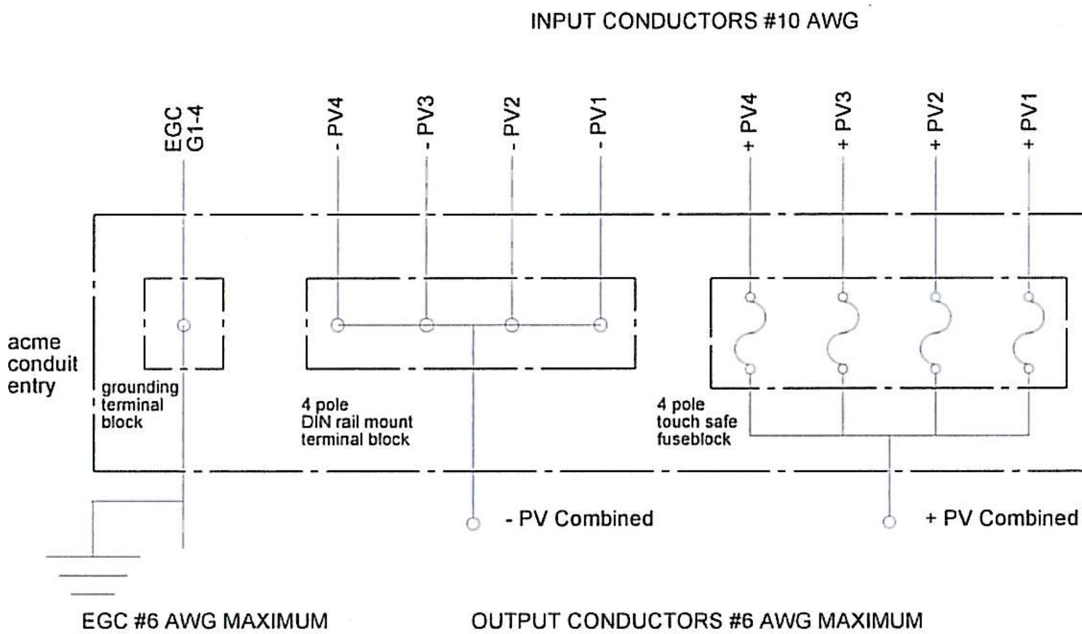

Figure 12: Wiring Diagram - Fused Combiner with DIN Rail-Mount Components, Negative Ground

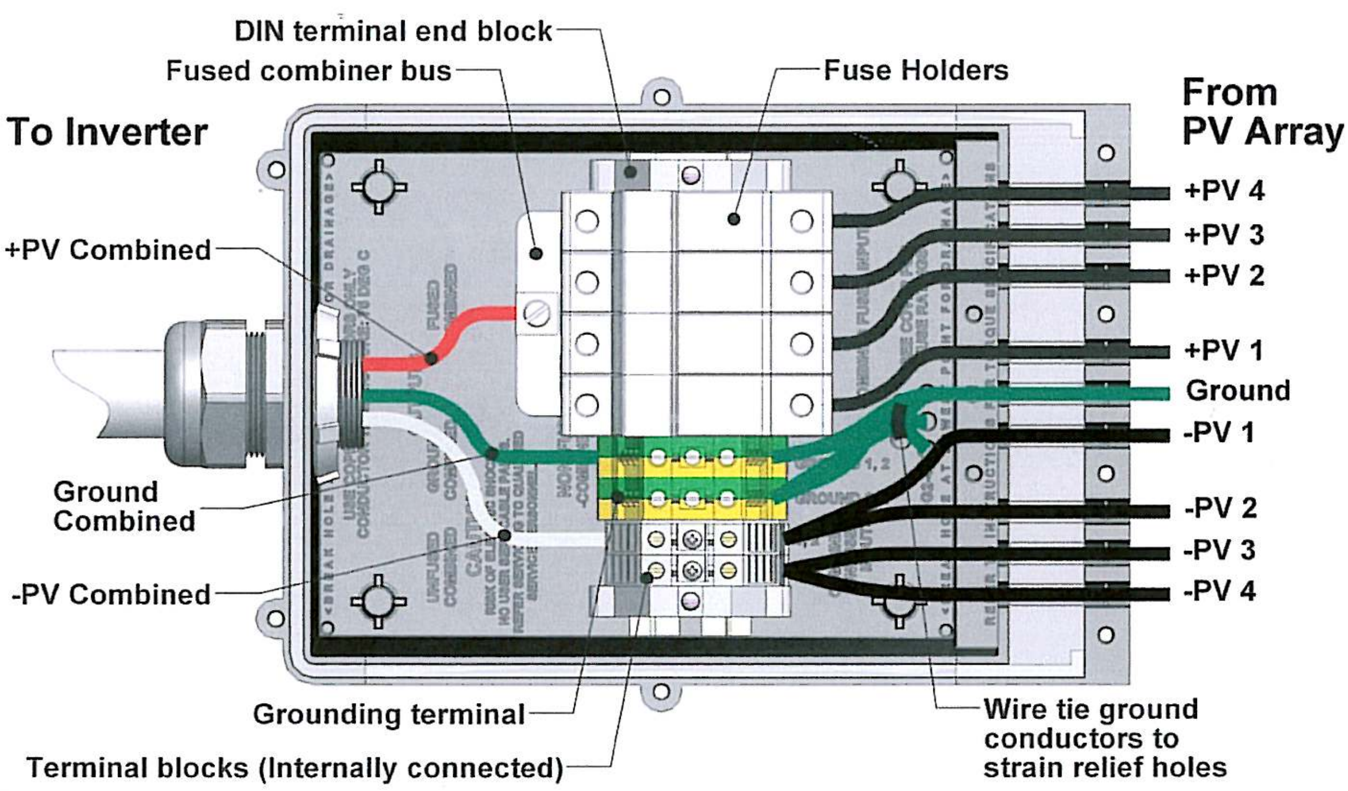

Figure 13: Wiring Layout - Fused Combiner with DIN Rail-Mount Components, Negative Ground

- Fused combiner with DIN rail-mount components, positive ground (3 or 4 strings)

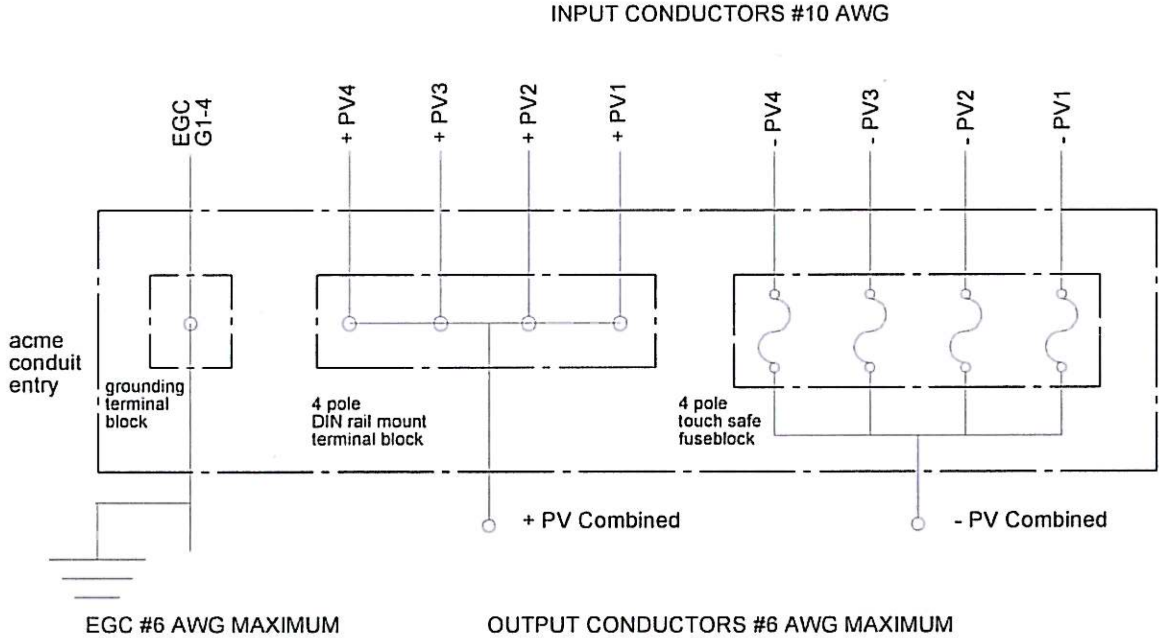

Figure 14: Wiring Diagram - Fused Combiner with DIN Rail Mount Components, Positive Ground

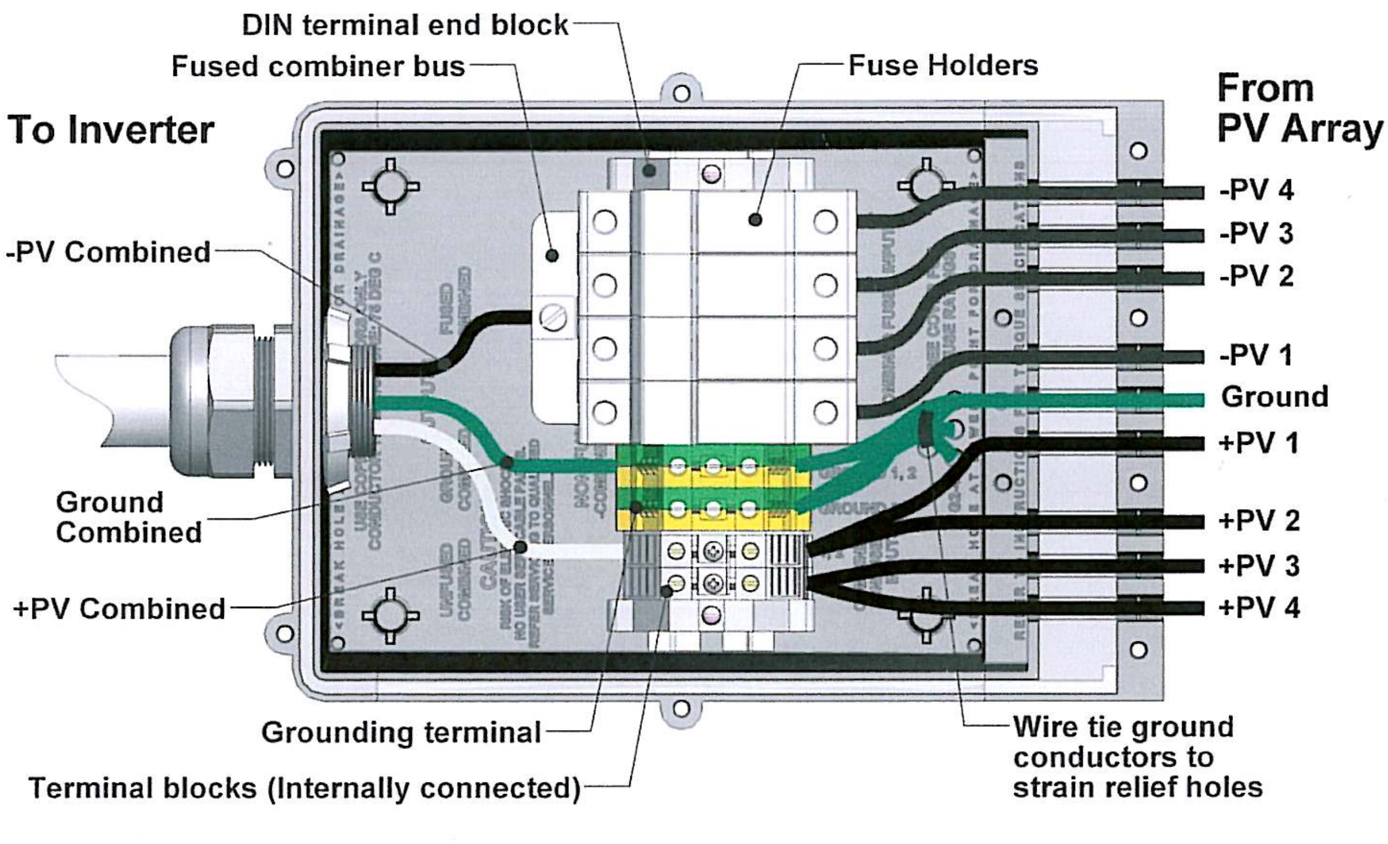

Figure 15: Wiring Layout - Fused Combiner with DIN Rail Mount Components, Positive Ground

The ACE provides grounding terminals that can accommodate up to four ground conductors. If more that one ground conductor is used, drill out the required ground conductor entry holes to accommodate the additional ground conductors.

- Two-string combiner with DIN rail-mount components, negative or positive ground

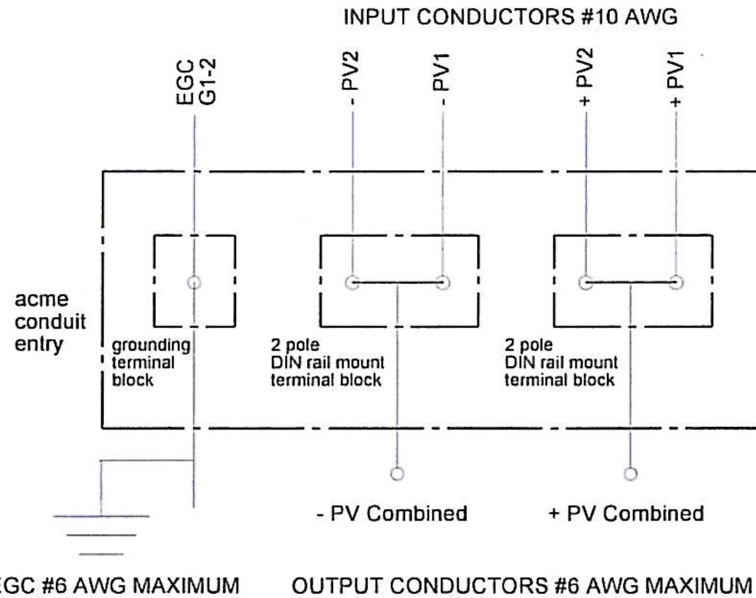

Figure 16: Wiring Diagram –Two-String Combiner with DIN Rail-Mount Components

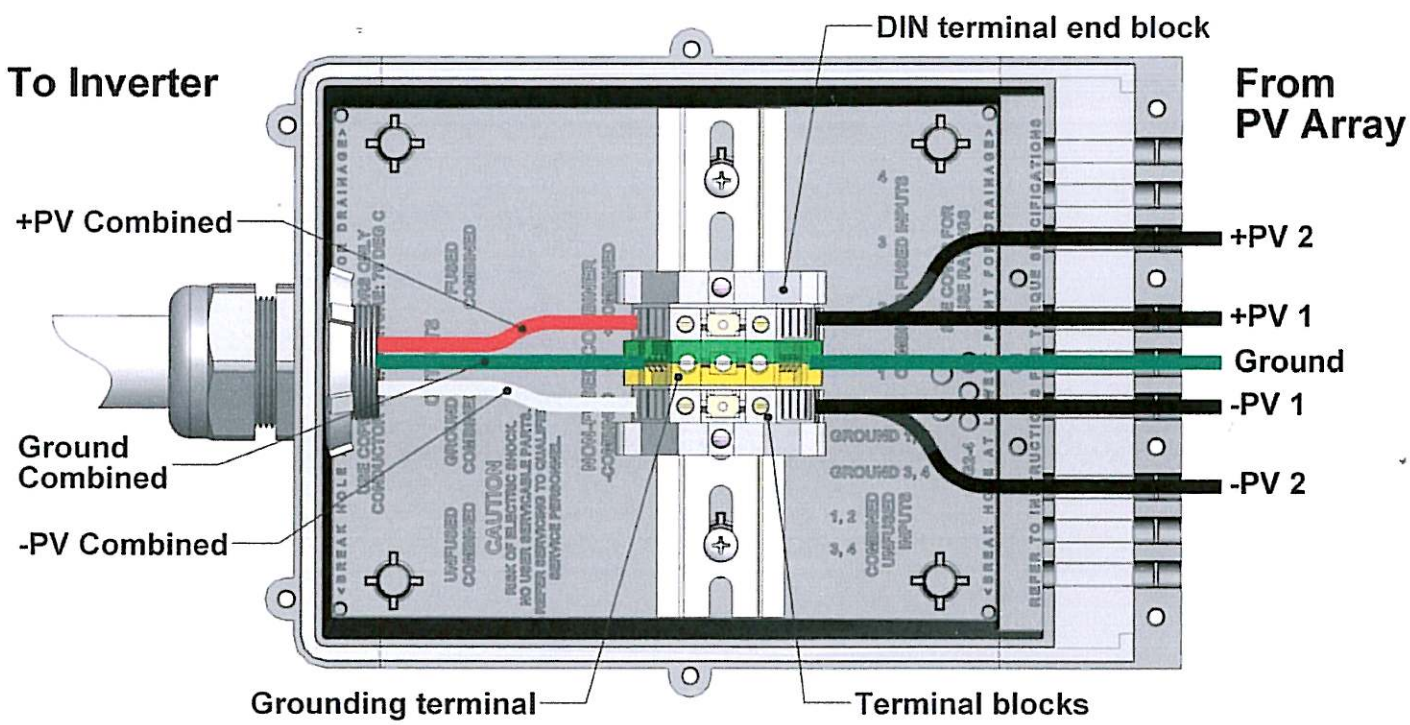

Figure 17: Wiring Layout – Two -String Combiner with DIN Rail Mount Components

Fuse Sizing

Fuses are used for overcurrent protection to prevent fire or damage to equipment. Selecting the appropriate size fuse for the circuit will allow current passage during normal operation and quick interruption during a short circuit or overload condition. Sizing a fuse that is too small will interrupt current passage during normal operation, while sizing a fuse that is too large will not provide protecting to the circuit during a short or overload condition. For PV systems, sizing of fuses are determined by the electrical rating of PV modules and the National Electric Code (NEC) requirements. Consult your PV module manufacturer to determine the appropriate size fuse.

Warning

- **Never open a fuse holder when it is under load. Arcing will occur causing damage to fuse holder. Always disconnect from the load before opening fuse holder.**
- **Wiring must have sufficient ampacity for the selected fuse. Size wires according to NEC requirements.**

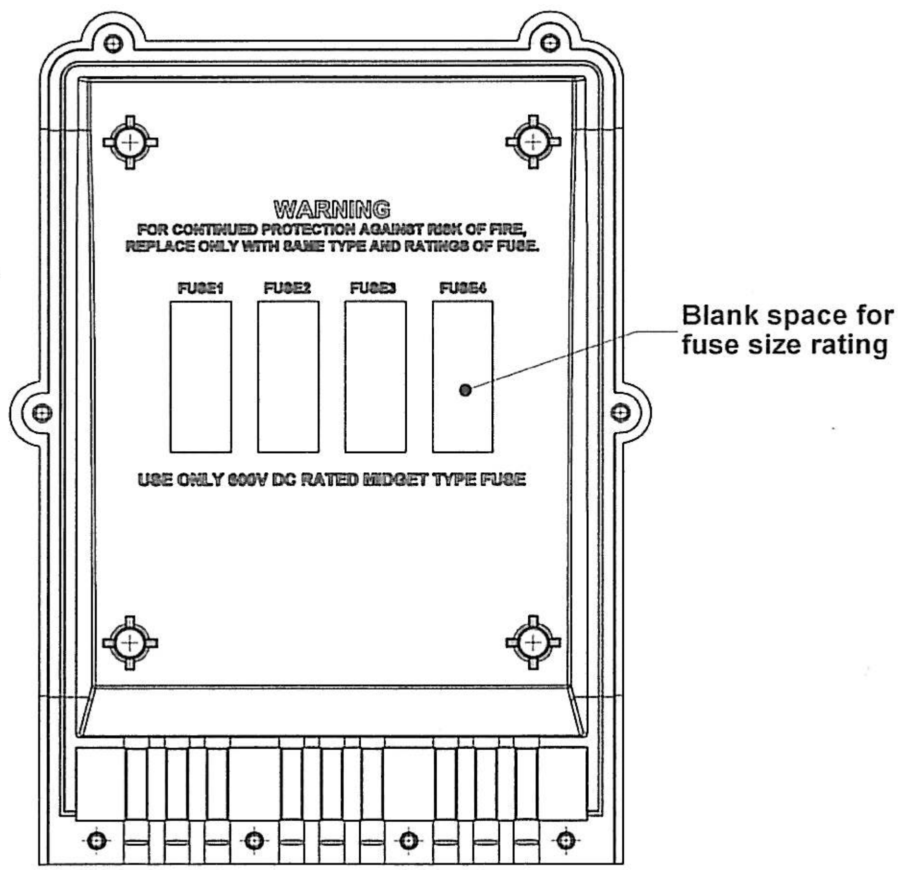

Figure 18: ACE Fuse Rating Location

Mark the fuse size in blank space provided using permanent white marker.

Specifications

Maximum Input Voltage	600V DC
Maximum Input Current	64A DC Continuous
Maximum Input Short Circuit Current	51A DC
Input Wire Diameter Range	5.0 - 6.8mm [0.20 - 0.27in] #10-12AWG USE-2/PV Wire
Maximum number of input conductor slots	9
Maximum number of PV strings	4
Maximum number of combined strings	4
Equipment Ground Conductor Diameter range	4.0 - 6.8mm [0.16 - 0.27in]
Acceptable Conduit sizes	19.05mm, 25.4mm [0.75in, 1.0in]
Internal Volume	1840cm^3 [112in^3]
Knockouts	Side and Bottom, 3/4" and 1"
Minimum Fuse Holder Tightening Torque	2.5 N-m [22 in-lb] for #18-8 AWG wires
Minimum Combiner Bus Tightening Torque	4.0 N-m [35 in-lb] for #14-6 AWG wires
Minimum Terminal Block Tightening Torque	2.0 N-m [18 in-lb] for #14-6 AWG wires
Minimum Grounding Terminal Tightening Torque	3.0 N-m [26 in-lb] for #10-6 AWG wires
Fuse Holder Wire Strip Length	12mm [0.47in]
Combiner Bus Terminal Wire Strip Length	12mm [0.47in]
Terminal Block Wire Strip Length	10mm [0.39in]
Grounding Terminal Wire Strip Length	14mm [0.55in]
Fuse Type	Midget 10 X 38mm, 600V DC

Table 3: Specifications

AUTHORIZATION TO MARK

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

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Country:	USA	**Country:**	USA
Contact:	Mr. Brian Wiley	**Contact:**	Mr. Brian Wiley
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Email:	btw@we-llc.com	**Email:**	btw@we-llc.com

Party Authorized To Apply Mark: Same as Manufacturer
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Control Number: 3098177 **Authorized by:** for Michelle Lake
William T. Starr, Certification Manager

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Standard(s):	UL Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, UL 1741. First Edition, May 7th 1999, Including Revisions through November 7, 2005.).
Product:	PV Combiner boxes
Brand Name:	N/A
Models:	ACE-PT, ACE-1P, ACE-2P, ACE-3P, ACE- 4P, ACE-2C, ACE-3C,AND ACE-4C

Guideline 1:

Permit Guidelines for Small-Scale PV Systems

1) Basic site diagram identifying location of major components—not to scale.

   This is a simple diagram to show where the equipment is located. This can be a zone clearance plot plan with the equipment clearly shown and identified on the plan. If PV array is ground-mounted, clearly show that system will be mounted within allowable zoned setbacks. See example EX-2 in appendix for reference.

2) One-line electric diagram showing all major field-installed electrical components, wire identification and sizing, and grounding.

   This diagram needs to have sufficient detail to call out the electrical components, the wire types and sizes, number of conductors, and conduit type and size where needed. This will typically include detailed module information, series/parallel configuration of modules, details of the Photovoltaic Output Circuit, wire type and size of module wiring, type and size of any junction or combiner boxes, approximate length of conductors in PV array, approximate length of conductors from junction box to the photovoltaic power source disconnecting means. Other important information includes equipment grounding of the PV array and system grounding of the inverter. It will also include specific information on the PV inverter and all associated wire in and out of the inverter. The utility disconnect (if required by the utility) type and location should also be called out on the diagram and the means of connection to the building electrical system. See example EX-1 in appendix for reference.

3) Major component information
   a) Inverter information
      i) Model number and manufacturer's "cut sheets" for the specific model.
      ii) Listing. Is the inverter listed by a Nationally Recognized Testing Laboratory (NRTL) to UL Std.1741 and labeled "Utility-Interactive"? If the utility-interactive labeling is not provided, does the unit comply with the requirements of IEEE Std. 929-2000 as verified the instruction manuals validated by the listing agency. For a current list of compliant inverters, visit the California Energy Commissions website, http://www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi. Some NRTLs have current listing information online as well.
      iii) Maximum continuous output power at 40°C
      iv) DC input voltage range
      v) AC output voltage range

   b) Module information
      i) Manufacturer's "cut sheets" for the specific model.
      ii) Listing. The module should be listed to UL 1703. For a current list of modules that are listed to UL 1703, visit the California Energy Commission's website, http://www.consumerenergycenter.org/cgi-bin/eligible_pvmodules.cgi.

Explanation: *This module information is particularly important since it is used to calculate several current and voltage parameters required by the National Electrical Code (NEC). Listing information is necessary for NEC testing requirements [90.7, 100,110.3]. (Numbers in brackets refer to sections in the 2002 NEC throughout this document.)*

iii) Open-circuit voltage (Voc)
Explanation: *Voc is needed to calculated maximum system voltage specified in NEC 690.7.*

iv) Maximum permissible system voltage
Explanation: *Maximum permissible system voltage (often 600 Vdc) is needed to show that the NEC 690.7 voltage does not exceed this value.*

v) Short-circuit current (Isc)
Explanation: *Isc is needed to calculate short-circuit current specified in NEC 690.8.*

vi) Maximum series fuse rating
Explanation: *Maximum series fuse rating is needed to ensure that the proper overcurrent protection is provided for the modules and array wiring.*

vii) Maximum power (Pmax) at Standard Test Conditions (STC, 1000W/m^2, 25°C cell temp)
Explanation: *Maximum power at STC specifies the rated power of the PV module under simulated conditions.*

viii) Operating voltage (Vpmax)
Explanation: *Vpmax is needed to calculate system operating voltage. This is the voltage of the module when operating at Pmax and STC.*

ix) Operating current (Ipmax)
Explanation: *Ipmax is needed to calculate system operating current. This is the current of the module when operating at Pmax and STC.*

c) Battery information (if used)

x) Manufacturer's "cut sheets" for the specific model.

xi) Nominal battery voltage for the system (Vbat)
Explanation: *This is 2 Volts per cell for lead-acid batteries. A 24-cell lead-acid battery would have a nominal voltage of 48 volts.*

4) Array information

a) Number of modules in series, number of parallel source circuits, and total number of modules.
Explanation: *Four items related to the PV array must be calculated and posted on a sign at the PV Power Source disconnect. The first item (i) characterizes the array design and provides the information necessary to calculate the four items needed to produce proper array identification for a sign required at the site.*

From Example in Appendix One:

Number of modules in series = 10
Number of parallel source circuits = 2
Total number of modules = 10 x 2 = 20

b) Operating voltage (sum of series modules operating voltage in source circuit)
Explanation: *Operating voltage is found by multiplying the module voltage at maximum power by the number of modules in a series string.*
From the example in Appendix One:
Vpmax = 33 Volts
Number of modules in series = 10
33 Volts x 10 = 330 Volts

c) Operating current (sum of parallel source circuit operating currents)
Explanation: *Operating current is found by multiplying the module current at maximum power for a module series string by the number of source circuits in parallel.*
From the example in Appendix One:
Ipmax = 4.25 amps
Number of source circuits in parallel = 2
4.25 amps x 2 = 8.5 amps

d) Maximum system voltage [690.7]
Explanation: *Maximum system voltage is calculated by multiplying the value of Voc on the listing label by the appropriate value on Table 690.7 in the NEC, and then multiplying that value by the number of modules in a series string. The table in the NEC is based on crystalline silicon modules and uses coldest expected temperature at a site to derive the correction factor. Some modules do not have the same temperature characteristics as crystalline silicon so the manufacturer's instructions must be consulted to determine the proper way to correct voltage based on coldest expected temperature. A conservative estimate for coldest expected temperature is the lowest recorded temperature at a location. An engineering evaluation may show that maximum voltage is less than this method suggests. If sufficient substantiation accompanies this evaluation, a lesser value for maximum system voltage should be allowed.*
From the example in Appendix One:
Module Voc = 42.8 Volts
Number of Modules in Series = 10
Lowest temperature on record = 15°F (coeff. Of 1.13 from 690.7)
Maximum System Voltage = 42.8 x 10 x 1.13 = 484 Volts < 600Volts

e) Short-circuit current [690.8]
Explanation: *Short-circuit current is calculated by multiplying the value of Isc on the listing label by the number of source circuits operating in parallel, then multiplying this value by 125% to account for extended periods of sunlight above the tested solar intensity (rated irradiance= 1000 W/m^2; maximum sustained irradiance= 1250 W/m^2).*
From the example in Appendix One:
Isc = 4.7 amps
Number of source circuits in parallel = 2
4.7 amps x 2 x 1.25 = 11.7 amps

5) Wiring and Overcurrent Protection

a) Wire Type:

PV module interconnections should be 90°C wet-rated conductors. Allowable wire types are as follows:

- USE-2 single conductor cable for exposed applications
- Type TC multiconductor cable for exposed applications with THWN-2 or XHHW-2 or RHW-2 or equivalent 90°C wet-rated conductors in the cable.
- Type THWN-2 or XHHW-2 or RHW-2 or equivalent 90°C wet-rated conductors in high temperature conduit (conduit rated for a minimum of 75°C wet conditions).

Explanation of need for high temperature wiring:

Typical temperature for PV modules in full sun at 20°C outdoor temperature is 50°C. This is a 30°C rise above outdoor temperatures. On the hottest day of the year, outdoor temperatures can reach 40-45°C in many locations throughout the United States. This means that the PV module will be operating at 75°C on the hottest day of the year (45°C+30°C =75°C). 75°C wire is insufficient for connection to a hot PV module under this condition and conduit rated for a minimum of 75°C wet conditions is necessary to contain wires that must be in conduit.

To further support the concern over the high temperature of PV modules, a new fine print note has been added to the 2005 NEC.

690.31 (A) FPN: Photovoltaic modules operate at elevated temperatures when exposed to high ambient temperatures and to bright sunlight. These temperatures may routinely exceed 70°C (158°F) in many locations. Module interconnection conductors are available with insulation rated for wet locations and a temperature rating of 90°C (194°F) or greater.

b) Conductor Ampacity:

Correct maximum current and ampacity calculations should be provided for each circuit. (Ampacity of conductors must be sufficient for application)

i) The maximum PV source circuit current is the sum of parallel module rated short circuit currents multiplied by 125 percent [690.8(A)(1)]. Explanation: *The 125 percent increase over the rated short circuit current is to account for sustained periods when the sun's intensity (irradiance) can be 25% greater than the rated irradiance. (rated irradiance= 1000 W/m^2; maximum sustained irradiance= 1250 W/m^2).*

From the example in Appendix One:

Isc = 4.7 amps

4.7 amps x 1.25 = 5.9 amps

ii) The minimum source circuit conductor ampacity is 125 percent of the maximum PV source circuit current [690.8(B)(1)].

Explanation: *The 125 percent increase over the maximum PV Source Circuit current is to account for the standard listing of wire to 80% of maximum circuit current for continuous duty.*

Example from Appendix One:

Minimum ampacity calculation
Isc = 4.7 amps
Maximum PV Source Circuit Current = 4.7 amps x 1.25 = 5.9 amps
Minimum Source Circuit Conductor Ampacity = 5.9 amps x 1.25 = 7.3 amps

iii) Minimum photovoltaic output circuit conductor ampacity is the sum of the maximum current of the parallel source circuits [690.8(B)(1)] times 1.25.

Explanation: *Paralleled currents add together. The 125 percent increase over the PV output circuit current is to account for the standard listing of wire to 80% of maximum circuit current for continuous duty.*

From the example in Appendix One:

Minimum Source Circuit Conductor Ampacity = 7.3 amps
Number of source circuits in parallel = 2
7.3 amps x 2 = 14.6 amps

Calculating ampacity of conductors used for the PV output circuit can be an involved process. If more than three current carrying conductors are installed in the conduit, Table 310.15(B)(2)(a) is used to adjust the conductor ampacity. If more than 10% of the circuit, or 10 feet of the circuit is in conduit in direct sunlight, Article 310.10 has a new fine print note in the 2005 NEC.

310.10 FPN No. 2: Conductors installed in conduit exposed to direct sunlight in close proximity to rooftops have been shown, under certain conditions, to experience a temperature rise of 17°C (30°F) above ambient temperature on which the ampacity is based.

This note instructs the installer to increase the apparent ambient temperature correction factor used in Table 310.16. For instance, should the maximum ambient temperature be 45°C (113°F), for rooftop sunlit conduit, the new ambient temperature is evaluated at 62°C (144°F). This has a dramatic impact on the allowable ampacity of a conductor.

iv) Minimum inverter output circuit conductor ampacity must be equal or greater than the inverter continuous output current rating times 1.25.

Explanation: *The inverter output circuit current is calculated from the maximum continuous power rating at nominal AC voltage. The 125 percent increase over the maximum Inverter Output Circuit current is to* *account for the standard listing of wire to 80% of maximum circuit current for continuous duty.*

<u>*From the example in Appendix One:*</u>

Inverter continuous output rating = 2500 Watts
Minimum inverter voltage = 211 Volts
Maximum operating current = 2500 Watts / 211 Volts = 12 Amps
Min. Inverter Output Circuit ampacity = 12 Amps x 1.25 = 15 Amps

c) Overcurrent protection: Necessary fuses or circuit breakers must be properly sized and specified for each circuit.

i) Source circuit overcurrent protection must be sized so that both the PV module and the conductor from the module to the overcurrent device are properly protected [690.9 (A), 240.20 (A)]. PV modules must be protected so that the maximum series fuse rating, printed on the listing label, is not exceeded. It is important to note that even though the listing label states "<u>fuse</u>" rating, a more accurate term would be the "maximum series <u>overcurrent protection</u>" rating since either a fuse or a circuit breaker may be used to satisfy this listing requirement. The module may be protected either by installing fuses or circuit breakers in a series string of modules or by the design of the PV system.

Inverters listed with a Maximum utility back feed current that is well above 1 amp (typically equal to the maximum allowable output overcurrent protection) must be assumed to provide back feed current to the PV array. Each source circuit must have overcurrent protection that is greater than or equal to the minimum PV Source Circuit current rating and less than or equal to the maximum series fuse rating.
<u>Explanation</u>: *For an array with a minimum source circuit current rating of 7.3 amps and a maximum series fuse rating of 15 amps, The minimum fuse rating would be 8 amps (next larger fuse rating above 7.3 amps) and the maximum would be 15 amps.*

For an inverter listed with a Maximum utility back feed current that is zero, or well under 1 amp (e.g. Fronius IG 5100), two source circuits can be connected to the inverter without requiring overcurrent protection on either circuit.
<u>Explanation</u>: *If an array is connected to a non-back feeding source containing two strings in parallel, the maximum current in a string is equal to the current from the other string in parallel. If the maximum current of each string is 5.9 Amps, then the maximum current at any PV module is 5.9 Amps and the maximum series fuse rating of the module will never be exceeded.*

ii) Battery (if used) overcurrent protection must have a sufficient voltage and ampere-interrupt rating (AIR) to withstand the operating conditions of the battery system. [NEC 690.9 (D)]

Explanation: *Batteries can produce thousands of amps of current during a short circuit. The overcurrent protection must be able to operate properly at the highest voltage produced by the battery and while exposed to the full the short circuit current supplied by the battery.*

iii) Inverter Output Circuit overcurrent protection should be sized and protected according the manufacturers directions. The circuit and corresponding overcurrent protection should be sized at a 125% of the maximum continuous output of the inverter [NEC 215.3 Overcurrent for Feeder Circuits]. The inverter may also have a maximum allowable overcurrent requirement.

Explanation: *For instance, the SMA SWR2500U has a maximum continuous output of 12 amps and a maximum allowable overcurrent protection of 15 amps. This means that the minimum allowable overcurrent is 15 amps (12 amps x 1.25 = 15 amps) and a maximum of 15 amps.*

iv) NEC 690.64 (B) covers the requirements for Point of Connection of the PV inverter to the building electrical system. The most common method of connection is through a dedicated circuit breaker to a panel busbar. The allowable size of the supply breaker depends on whether or not the facility is a dwelling. If the building is a dwelling, the sum of the supply breakers feeding the busbar of a panel can be up to 120% of the busbar rating. Non-dwelling facilities do not allow the sum of the supply breakers to exceed the busbar rating.

Explanation: *A dwelling with a service panel containing a 100-amp busbar and a 100-amp main breaker will allow breakers totaling 120% of the busbar rating (120-amps). Since the main breaker is 100 amps, the PV breaker can be up to 20 amps without exceeding the 120% allowance. For a service panel with a 125-amp busbar and a 100-amp main breaker, this provision will allow up to a 50 amp breaker (125 amps x 1.2 = 150 amps; 150 amps – 100 amp main breaker = 50 amp PV breaker).*

v) A new provision in the 2005 NEC clarifies the fact that dedicated circuit breakers backfed from listed utility-interactive inverters do not need to be individually clamped to the panelboard bus bars. This has always the case, but many inspectors have employed the provisions of NEC 408.36(F) that the breaker be secured in place by additional fastener. Utility-interactive inverters do not require this fastener since they are designed to shut down immediately should the dedicated breaker become disconnected from the bus bar under any condition.

NEC 690.64 (B) covers the requirements for Point of Connection of the PV inverter to the building electrical system. The most common method of connection

6) Provisions for the photovoltaic power source disconnecting means:

The 2005 NEC states in 690.14(C)(1), "Location. The photovoltaic disconnecting means shall be installed at a readily accessible location either outside of a building or structure or inside nearest the point of entrance of the system conductors. The photovoltaic system disconnecting means shall not be installed in bathrooms."

i) Readily accessible—Article 100 states, "*Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, and so forth.*
ii) Readily accessible provision is primarily for emergency operation. If the disconnect is not mounted in close proximity of the service entrance disconnect (usually within 10 feet of the meter location or service disconnect switch), then a diagram or directory must be provided to clearly identify where the disconnect is located.
iii) A rooftop disconnect on a residential roof will normally not qualify as a readily accessible disconnect.

A new exception to this requirement has been added to provide additional clarification for residential and building integrated PV systems. This exception reads:

"Exception: Installations that comply with 690.31(E) shall be permitted to have the disconnecting means located remote from the point of entry of the system conductors."

690.31(E) states:

"**(E) Direct-Current Photovoltaic Source and Output Circuits Inside a Building.** Where direct current photovoltaic source or output circuits of a utility-interactive inverter from a building-integrated or other photovoltaic system are run inside a building or structure, they shall be contained in metallic raceways or enclosures from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means. The disconnecting means shall comply with 690.14(A) through 690.14(D)."

Although metal-clad cable is not specifically called out in 690.31(E), many jurisdictions consider installations with metal-clad cable as meeting the intent of this new provision. Note that this new section specifically mentions building-integrated systems. The way the 2002 NEC was written, a roof-integrated PV system cannot reasonably comply the 690.14(C)(1) as written.

Those jurisdictions that remain on the 2002 NEC need to consider two alternative approaches to the provisions of 690.14(C)(1).

Suggested alternative approaches:

(1) Follow the new exception in the 2005 NEC and require that all wiring once within the building be installed in metallic raceways or enclosures, or metal-clad cable from the point of penetration of the building to the first readily accessible disconnecting means.
(2) Consider applying the requirements of NEC 440.14 for Air-Conditioning and Refrigerating Equipment only requires that the disconnect be "readily accessible from the air conditioning or refrigerating equipment." Following this provision would require a clearly marked rooftop disconnect that can be easily operated by emergency personnel on the roof with an appropriate sign at the service entrance providing (1) a warning of voltage, (2) how to shut down system prior to getting on roof, and (3) location of disconnect on the roof.

7) Grounding
The NEC requires [690.41] that all systems operating above 50 volts have one conductor referenced to ground unless the system complies with the requirements of 690.35 for ungrounded PV arrays.

Some inspectors have insisted upon the grounding connection point of the array to be near the array since the fine print note in 690.42 states "FPN: Locating the grounding connection point as close as practicable to the photovoltaic source better protects the system from voltage surges due to lightning." Although this may be an accurate statement, changing the grounding location necessitates that inverter be moved to the grounding location since many inverters require that the array be grounded in the inverter. There are many reasons why moving the inverter away from the service entrance is not good design and these reasons generally outweigh any lightning protection benefits received by grounding the system conductors near the array.

The code also requires that all exposed non-current-carrying metal parts of module frames, equipment, and conductor enclosures be grounded regardless of system voltage [690.43].

a) Equipment grounding conductor sizing [690.45]
The size of the equipment grounding conductor is dependent on whether the system has ground fault protection (GFP) equipment or not. The provisions for GFP equipment are stated in 690.5. Many residential inverters have GFP equipment integral to the inverter and require that the PV array be grounded at the inverter only.

i) Systems without ground fault protection equipment
The NEC requires that equipment grounding conductors for systems without GFP equipment be sized for 125% of circuit short circuit current [690.45]

(calculated in 5)b)i) in this guide). The shortcut method of sizing this conductor is simply to size the equipment grounding conductor the same size as the current carrying conductors. Calculating 125% of circuit Isc may produce a conductor size that is one size smaller than the current carrying conductors, but that must be calculated for confirmation.

ii) Systems with ground fault protection equipment
Size equipment grounding conductor according to NEC Table 250.122.

b) System grounding conductor sizing

i) AC System
Size grounding electrode conductor according to NEC Table 250.66

iii) DC System
Size grounding electrode conductor according to NEC 250.166. This results in a minimum size of 8 AWG.

8) Array Mounting information

Provide information on weight of array (pounds per square foot). This includes the weight of the modules and all panelizing hardware (e.g. modules, rails and associated hardware).

a) If array is roof mounted:

Provide information on roof structure(s) construction (truss or rafter size and spacing) and roofing material.

i) Is the weight distribution of the system greater than 5 lbs. per square foot? If yes, engineering calculations may be required.

ii) Is the roof structure more than 30 years old? If yes, specify rafter or truss size and spacing—engineering calculations may be required if non-standard.
Explanation: *Subpoint (i) refers to the broad inspection practice that allows additional layers of comp shingles as long as the weight is limited to no more than an additional 5 lbs/ft^2. This provides a conservative structural weight threshold without the need for a structural engineer to review the roof structure. Subpoint (ii) refers to the fact that the code enforcement of roof structural elements has been much more consistent across the United States in the last 30 years. However, there may be many local jurisdictions who have been carefully reviewing roof structures for a much longer period of time. The local jurisdiction should consider extending this limit based on the period that roofs have been consistently inspected.*

iii) Identify roofing type (e.g. comp shingle, masonry tile, shake, etc...)

iv) Provide engineering details of PV panel mounting attachment to the roof-framing members. Several well-engineered mounting systems are now available for installers to use. These designs often include detailed engineering specifications and details. Installers who use their own designs will need to provide their own details and engineering calculations with their design.

v) Identify method of sealing roof penetrations (e.g. flashing, sealed with urethane caulk, etc...)

b) If array is ground mounted:

   i) Show array supports, framing members, and foundation posts and footings.
   ii) Provide information on mounting structure(s) construction. If the mounting structure is unfamiliar to the local jurisdiction and is more than six (6) feet above grade, it may require engineering calculations.
   iii) Show detail on module attachment method to mounting structure.

9) Costs of Permits

Each jurisdiction may have different internal costs structures and approaches to working with solar PV systems. The following section is provided as a suggestion in developing the cost structure for a local jurisdiction.

Costs for permits are often based on the overall project cost. This works well for many conventional projects because this accurately represents the scale of the project. However, with a PV installation, the equipment costs are much higher than with other projects of similar scope. It is therefore recommended that an alternative permit fee scale be used for PV system installations. The scope of a PV installation is similar to that of installing a retrofitted residential HVAC system. The permitting costs for a PV system should be similar to those for an HVAC system.

Although initial plan review and field inspection costs may be slightly higher for the first few systems, those costs should reduce as the local jurisdiction becomes familiar with the installations. A subdivision of more than 10 units should be considered for an additional fee reduction based on the repetitive nature of the reviews. A suggested fee schedule is as follows:

Small PV system (up to 4 kW): $75 - $200
Large PV system (up to 10 kW): $150 - $400

For systems above 10 kW, consider a permit cost of $15 - $40 per kW.

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