PWA-COM-XXXX PV Combiner Box

User's Manual

CONTENTS

FIGURES

TABLES

1. IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

The PWA PV Combiner (PWA-COM-XXXX) is compatible with and intended for part of a complete Energy Storage System in which is both: properly rated and installed. In addition, the PWA-COM-XXXX Combiner family may also be used with any PV array and inverter for which it is suitably rated.

Before using the PWA-COM-XXXX Combiner, please read all instructions and caution markings in this manual and product and warning label within the Combiner product, as well as all other instructions and warnings for associated equipment.

This manual contains important instructions that must be followed during installation and operation of the PWA-COM-XXXX Combiner. To reduce the risk of electrical shock and to ensure the safe installation and operation of the Combiner, the following safety symbols are used to indicate dangerous conditions and important safety instructions.

WARNING
Could Injure Personnel or Damage Equipment

Instructions for Qualified Personnel Only

Positive Connection Point Symbol

Negative Connection Point Symbol

Ground Connection Point Symbol

DC Electrical Connection Point Symbol

WARNING: Disconnect all PV modules before wiring. PV arrays produce dc voltage when exposed to light and could create a hazardous condition. Always verify the absence of voltage before performing work on the PWA-COM-XXXX Combiner.

WARNING: Connecting PV output circuits to the input of the Combiner and making the connection to the DC Re-Combiner, must only be done after receiving approval from the utility company, and should only be performed by qualified persons, following the guidelines found within this manual.

WARNING: The PWA-COM-XXXX Combiner is intended to be used in any PV array as part of the energy storage system for which it is suitably rated.

---

2. PRODUCT OVERVIEW

The primary function of the PWA-COM-XXXX Combiner is to combine PV Source Circuits from a PV array in parallel, safely, and form a resulting PV Output Circuit for connection to downstream equipment. The PWA-COM-XXXX is intended for use as part of an Energy Storage System.

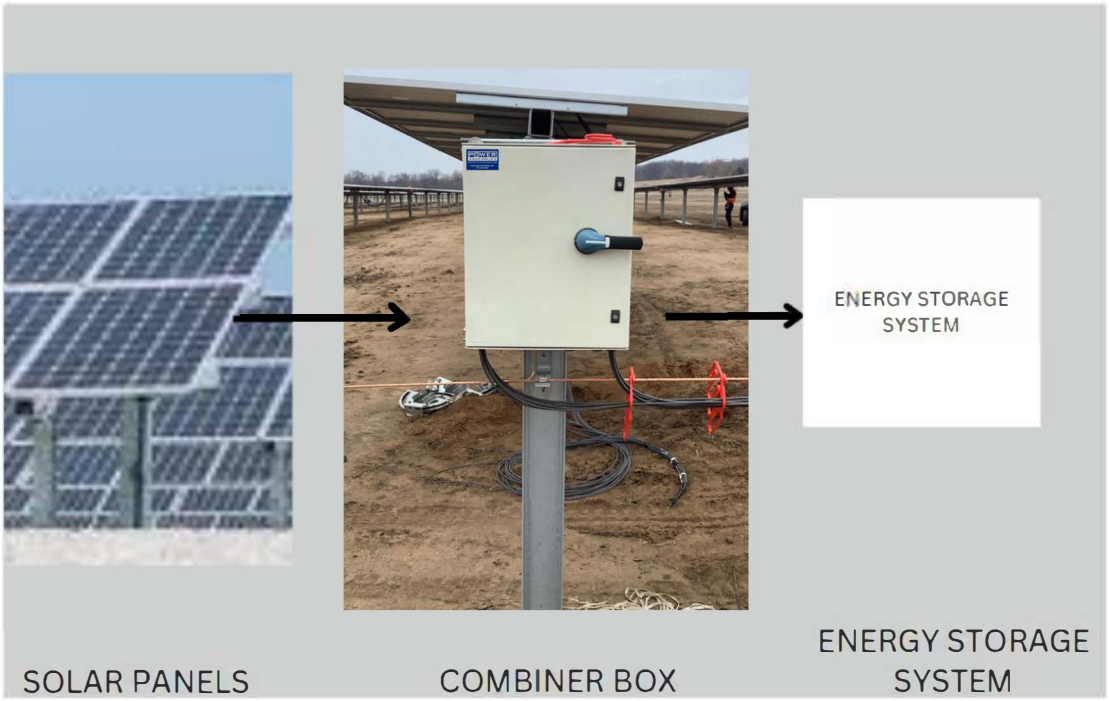


Figure 2.1

Figure 2.1 – Illustrated Example Usage of the Photovoltaic Combiner in an Energy Storage System Application

The PWA-COM-XXXX Combiners (see Fig 2.2) perform the following functions:

(1) **PV Source Circuit Connections**:

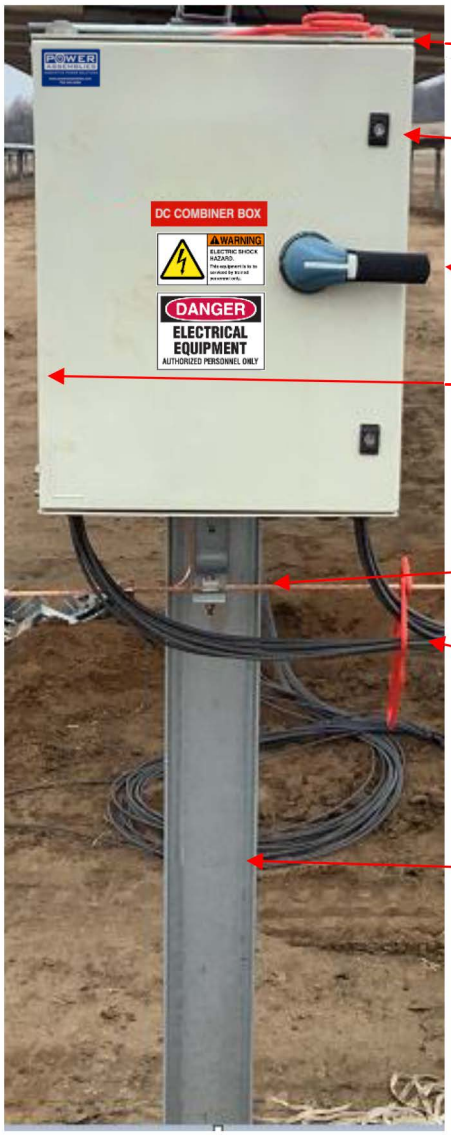
- Touch-safe fuse holders; model is a 19-String positive-polarity PV Source Circuit conductors
- Overcurrent protection provided by PV Fuses sized accordingly.
- A 20-position bus for termination of the negative-polarity PV Source Circuit conductors
- Connection from all PV Source Circuit conductors to the internal DC bus

(2) **DC Disconnect Switch**:

- DC disconnect switch, 400A, two-pole, fully integrated and externally operable; separates the combined PV Source Circuits from the PV Output Circuit terminals and conductors

(3) **PV Output Circuit Connections**:

- Terminals accommodating single 750kcmil conductors or dual 500kcmil conductors per pole, for the field-installed PV Output Circuit conductors.
- Type II surge protection, factory installed.



Mounting Tabs, Four Places

¼ Turn Integrated Fastener, Two Places

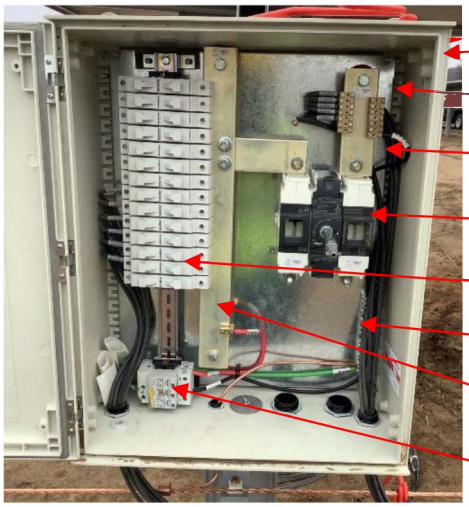
400A, 1500V, 2-POLE DC DISCONNECT SWITCH

HINGED COVER

FIELD GROUNDING EXAMPLE (Customer Supplied)

BOTTOM ENTRY CABLING (Customer Supplied)

MOUNTING POLE EXAMPLE (Customer Supplied)



Enclosure

NEGATIVE PV CONDUCTOR CONNECTION POINT

NEGATIVE BUS BAR

400A DC SWITCH (Output power connection point is on bottom of DC Switch)

FUSING FOR UP TO 19 POSITIVE CONDUCTORS

GROUND LUG

POSITIVE BUS BAR

SURGE PROTECTOR

FIGURE 2.2 The PWA-COM-XXXX DC Combiner

3. RATINGS AND SPECIFICATIONS

PWA-COM-XXXX SPECIFICATIONS	
PV SOURCE CIRCUIT CONNECTIONS	
Maximum Voltage	1500VDC
Fuse holder • Wire Compatibility • Required Torque • Temperature Rating • Other	 • 14 – 4AWG, PV-Rated, Copper Wire Only • 22 in-lb (2.5 N-m) • -40°C to +125°C • Touch-safe, lock-out/tag-out feature
Fuse • Rating • Type	 • 20A, 25A, 30A or 32A, 1500VDC • Replace only with SPXV SERIES SOLAR FUSE, or equivalent photovoltaic fuse
Number of Fuse Positions	Up To 19 Positions
Fuse Configuration	Fusing for Positive Polarity Only
DC DISCONNECT SWITCH	
Configuration	2-pole, 400A, 1500VDC, externally operable
Maximum Current Rating	400A
PV OUTPUT CIRCUIT CONNECTIONS	
Maximum Voltage	1500VDC
Maximum Wire Size Compatibility	Cu: 1 cond, 750 kcmil; 2 cond, 500 kcmil Al: 1 cond, 750 kcmil; 2 cond, 500 kcmil EGC Range: 14 AWG – 2/0 AWG
MECHANICAL, ENVIRONMENTAL, SAFETY	
Enclosure Dimensions (not including mounting tabs, see Fig. 4.1)	Height: 30.0 in (762mm) Width: 24.0 in (610mm) Depth:10.0 in (254mm)
Enclosure Material & Rating	Polyester Powder-Coated Steel, Type 4
Weight	85 lbs
Ambient Temperature Range	-40°F to 130°F (-40°C to +54°C)
Surge Protection (Optional)	Type 2, +/-/GND, Common/Differential Modes
Safety Certification & Listing / Certification Agency	Intertek, UL1741
Standard Warranty	2 Years standard

Table 3.1 – PWA-COM-XXXX Combiner Specifications

4. INSTALLATION

The steps for successful installation of the PWA-COM-XXXX Combiners are:

(1) Unpacking and Inspection
(2) Mounting
(3) Conduit and Fittings
(4) Wiring and Conductor Installation
(5) Testing and Commissioning

4.1 Unpacking and Inspection

4.1.1 Check for Damage

Power Assemblies thoroughly inspects and rigourously tests all our PV Combiner Boxes before it is shipped. Even though the Combiners are delivered in rugged packaging, damage could occur to the Combiners during shipment.

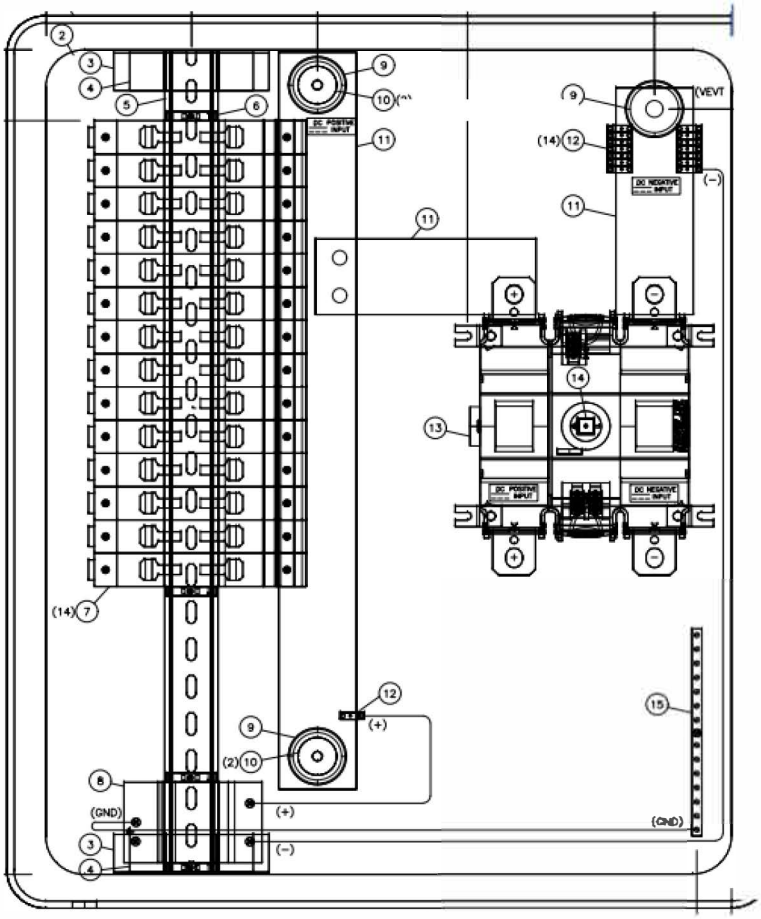
- ✓ Inspect the Combiner after removing it from its packaging. Take care not to set the Combiner on gravel or other surface that could scratch the paint.
- ✓ If damage is observed, take digital photos to document the damage and immediately report the damage to the shipping company.
- ✓ If the recipient has any question about the potential shipping damage, contact your Power Assemblies Sales representative. (Section 6 for contact information).
- ✓ If Power Assemblies determines that the Combiner must be returned, obtain an RMA number from Power Assemblies and instructions to return the unit.

4.1.2 Remove Packing Material Inside the Combiner

Remove and properly dispose of all cardboard, tape and other packing material that may be inside the Combiner enclosure.

4.2 Mounting

The Power Assemblies Combiner Box is designed to mount in any convenient location. Typically, the Power Assemblies Combiner will be mounted in the PV array, close to the input PV Source Circuits and some distance from the Energy Storage System equipment. The Power Assemblies Combiner is equipped with four integrated mounting tabs (see Fig. 4.1 and Fig 4.2) to understand major components used & to facilitate attachment for mounting. The Power Assemblies 1500-400 enclosure is rated Type 4 and will maintain this rating when the user follows appropriate installation methods.



COMBINER BOX 1		
NO.	QTY	DESCRIPTION
1	1	1500VDC COMBINER BOX, ENCLOSURE, 23⅝"H x 19¹³⁄₁₆"W x 9⅛"D, 400A TYPE 4X
2	1	ENCLOSURE BACK PLATE, 21¹³⁄₁₆"H x 17¹³⁄₁₆"W x ⅛"D
3	2	FLAT BAR, 4" x 1" x ⅛"
4	2	DIN RAIL STANDOFF BRACKET
5	A/R	DIN RAIL, 35MM X 7.5MM SLOTTED
6	4	TERMINAL BLOCK, END BRACKET
7	14	POSITIVE TERMINAL, 32A, 1500VDC, FUSE HOLDER
8	1	DPS0PVS – 1500/51, SURGE PROTECTION DEVICE
9	3	INSULATOR
10	4	WASHER
11	A/R	SV 3580 BUSBAR E-CU, 1/4" x 2"
12	15	TERMINAL, CONDUCTOR CONNECTION CLAMP SV 3555
13	1	PV/DC SWITCH, INDSYS LBS
14	1	DIRECT HANDLE
15	1	GROUND STRIP

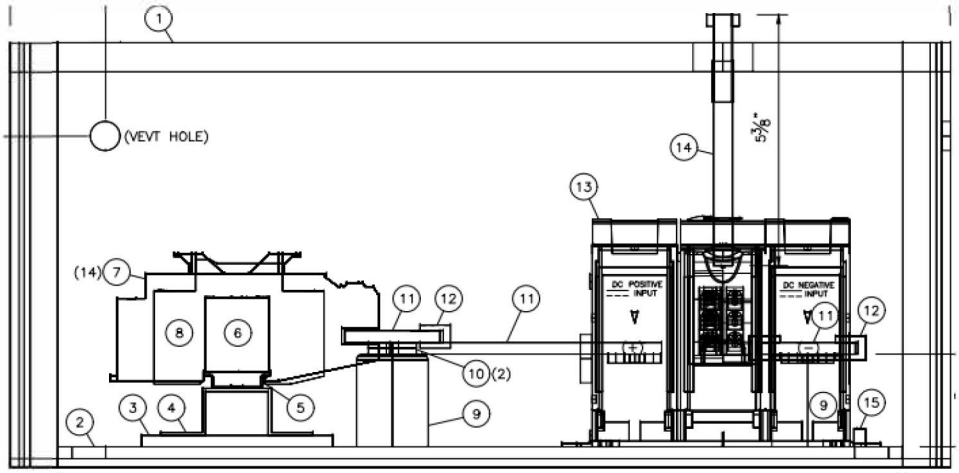


Fig. 4.1 PWA-COM-XXXX Major Component Identification and Location

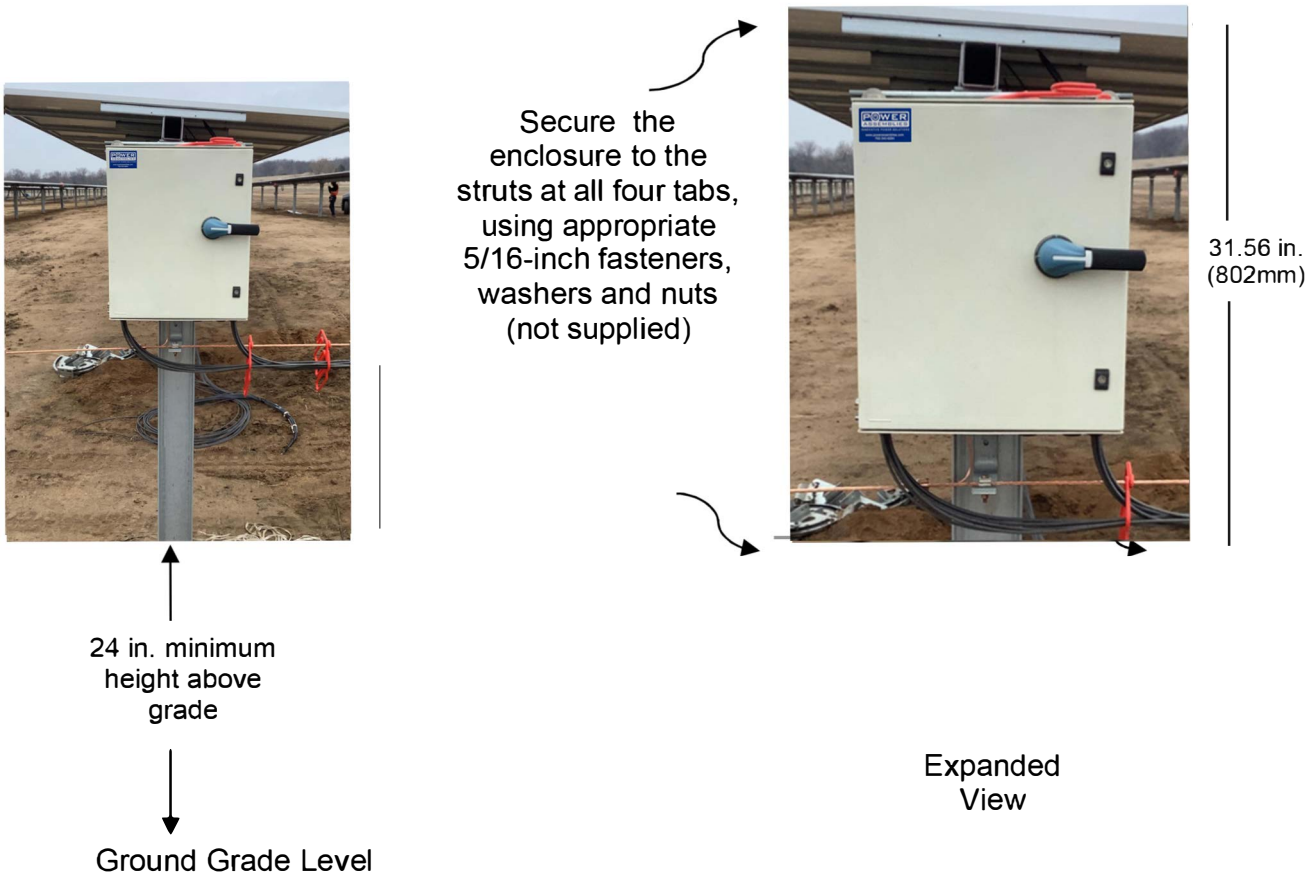


Fig. Power Assemblies PV Combiner Recommended Installation

4.3 Wiring

Completing the installation of the PWA-COM-XXXX Combiner Box requires: (1) field wiring of the PV Source Circuits (up to 19) -- positive polarity conductors to the fuse holders, negative polarity conductors to the 20-position negative terminal block, and equipment ground wires to the equipment ground terminals, and (2) field wiring of conductors from the PV Output Circuit terminals and the equipment ground lug to the **E**nergy **S**torage **S**ystem **C**omponents (**ESSC**, Not Supplied by Power Assemblies).

STEP 1: Confirm That No Wiring is Connected to the Combiner

- ✓ This is the first step of the installation and no wiring should be present into or out of the PWA-COM-XXXX Combiner. No input PV Source Circuits conductors should be present, and no PV Output Circuit conductors should be present.
- ✓ If there is ESSC components in place, confirm that the DC disconnect(s) switch is/are on the OFF position. All other equipment should be disconnected even though the wiring between the PWA-COM-XXXX Combiner and other equipment may or may not yet be in place. The window on the disconnect switch body will show the "O" (Off) switch status.
- ✓ Ensure that all fuse holder are pulled into their open position (Not pressed into the body of the fuse terminal) and that no fuses are installed. If there are fuses installed, remove fuses from all the touch-safe fuse holders in the and safely store the fuses for later re-installation.

STEP 2: Prepare the Enclosure for Conduits

- ✓ Conduit and strain reliefs can be located anywhere suitable on the bottom face of the Combiner as shown in Figure 4.3.
- ✓ Add the necessary holes for the conduit and fittings. The PWA-COM-XXXX Combiner provides adequate space for strain reliefs, readily accommodating up to 19 pairs of conductors from 19 input PV Source Circuits, the maximum allowable.
- ✓ Remove all metal shavings and all debris from the inside of the Combiner.

Remove all metal shavings and debris from the inside of the Photovoltaic Combiner Box.

Fig 4.3 Bottom of the PWA-COM-XXXX Enclosure

Conduit Connections

Conduits connected to an outdoor enclosure can introduce water vapor into the enclosure and lead to the formation of condensation inside. Failure to follow these guidelines can result in water intrusion into the unit through the conduit connections and may void the warranty.

Follow these instructions and best practices when securing conduits to the Re-Combiner.

1. Use UL514B certified water-tight conduit fittings and proper installation methods to provide a water-tight connection that will maintain the NEMA rating of the enclosure.
2. Use an appropriately rated sealant and seal the conduits fully to prevent the exchange of air between the conduit and the enclosure. Sealing the conduit will help prevent condensation in the enclosure.

STEP 3: PV Source Circuit Connections

Do not attempt to make connections to the PWA-COM-XXXX Combiner if you are not qualified for electrical work.

FUSEHOLDER SPECIFICATIONS	
Wire Compatibility	14 AWG – 6 AWG stranded 14 AWG – 10 AWG solid 90°C Copper Conductors Only
Voltage Rating	1500 VDC
Ampere Range	Up to 32A
Torque Setting	22 in-lb, #2 Phillips

Table 4.1 – Fuse holder Specifications

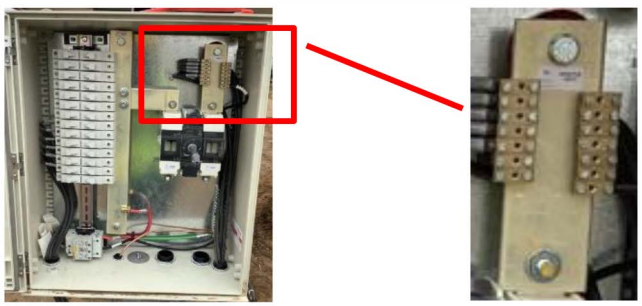
- ✓ Verify absence of voltage in PV Source Circuit conductors.
- ✓ Run the PV Source Circuit conductors into the Combiner either through conduit or strain-relief connectors, following the WARNING above to prevent condensation within the enclosure.
- ✓ Connect the positive conductors to the touch-safe fuse holders, one conductor perfuse holder.
- ✓ Connect the negative conductors to the negative polarity terminals (not fused).
- ✓ Connect equipment ground conductors to the equipment ground terminals.
- ✓ Torque each PV Source Circuit conductor to 22 in-lb with a #2 Phillips screwdriver.

Only replace fuses in the PWA-COM-XXXX Combiner fuse holders with appropriately-rated 10x85mm, 1500Vdc photovoltaic fuses. An example fuse is identified in the table below.

Fuse Rating	Part Number
25A	Littlefuse SPXV 25A - M

Table 4.2 – Example 1500VDC Replacement PV Fuse

Negative PV Source Circuit conductors terminate on the 20-position terminal block, with the following specifications. Note # of terminals determined by number of Strings, as shown is 14-String.



- 20 position
- 14 AWG
- Copper and Aluminum
- 90C Rating
- Torque to 18 in-lb
- Allen wrench (not provided)

STEP 4: PV Output Circuit Connections

The PWA-COM-XXXX Combiner provides tabs, as part of the 400A DC Switch (mounting plates, and lugs are not supplied), just below the DC disconnect switch body. The terminals are rated for 90°C. Refer to NEC Articles 310 and 690 for proper sizing of conductors. Basic specifications are in Table 4.3.

Wire Terminal Temperature Rating	Number of Terminals	Number of Wires per Terminal Allowed	Max Conductor Size Allowed (Copper or Aluminum Conductors)
90°C	1 per pole	1 – 2	(2) 500 kcmil or (1) 750 kcmil

Table 4.3 – PV Output Circuit Terminal Specifications

Compression lugs & mounting plates are NOT provided with the PWA-COM-XXXX Combiner Box. The lugs must conform to the specifications given in the table below:

Lug Type	Stud Spacing	Plating	Max. Tongue Width
Two-hole	1.75 in	Tin Plated	1.95 in

Table 4.4 – Compression Lug Specifications

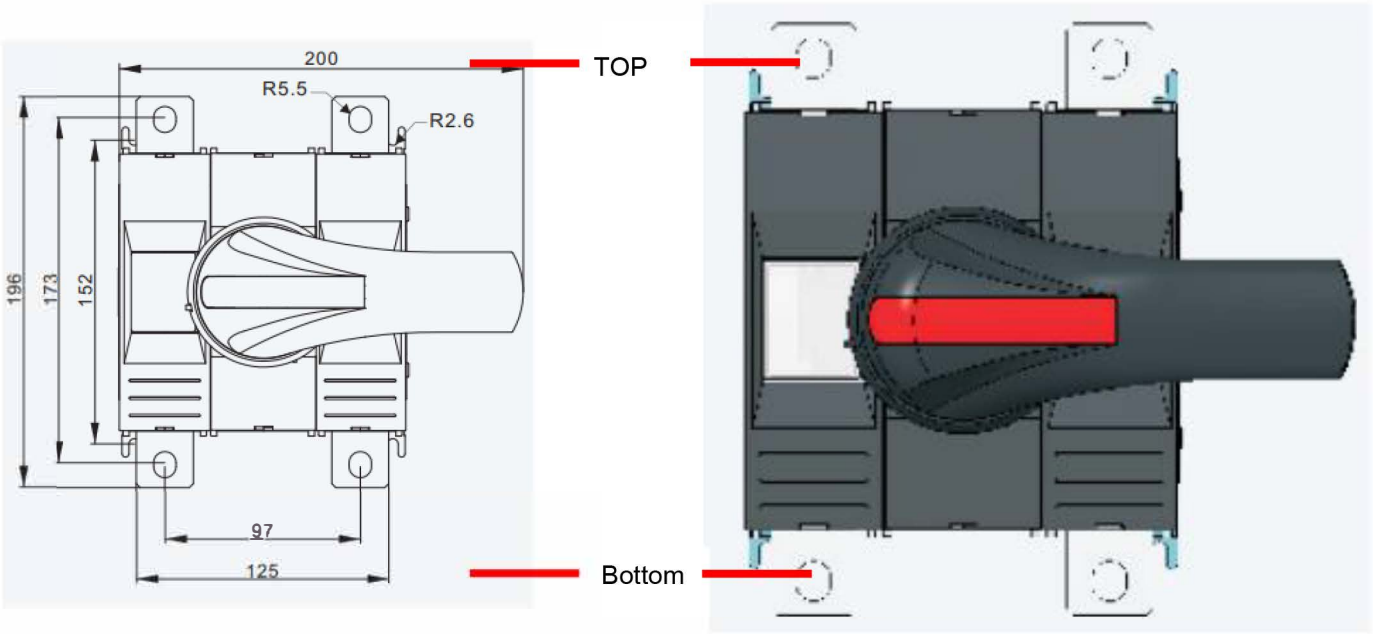


Figure 4.4 – PV Output Circuit Stud Plates (top view)
PWA-COM-XXXX (Dimension listed in mm)

For the hardware mounted to the bottom side of the DC Switch, use the following.

Fasteners	8mm flanged nut, SS Torque: 90 in-lb (10 Nm)

Conductor Size	Stud Size	Color Code	Dimensions (mm)					
			O.D.	I.D.	A	A1	B	C
6AWG	5/16	Gray	8.60	5.10	51.00	21.80	14.40	2.50
4AWG	5/16	Green	11.20	6.40	58.60	27.00	14.40	4.80
2AWG	3/8	Pink	13.50	7.90	63.50	30.50	18.00	5.50
2AWG	1/2	Pink	13.50	7.90	63.50	30.50	18.00	5.50
1AWG	3/8	Gold	13.50	8.90	63.50	30.50	18.50	4.50
1AWG	1/2	Gold	13.50	8.90	63.50	30.50	18.50	4.50
1/0AWG	3/8	Tan	16.00	9.90	71.30	30.50	21.50	6.10
1/0AWG	1/2	Tan	16.00	9.90	71.30	30.50	21.50	6.10
2/0AWG	1/2	Olive	17.50	11.20	71.30	33.00	23.80	6.10
3/0AWG	1/2	Ruby	19.30	12.20	76.20	35.60	26.10	7.10
4/0AWG	1/2	White	21.30	14.00	87.10	35.60	29.20	7.30
4/0AWG	5/8	White	21.30	14.00	87.10	35.60	29.20	7.30
250MCM	1/2	Red	23.40	15.00	88.90	38.10	32.00	8.10
300MCM	1/2	Dark Blue	25.70	16.50	101.60	40.60	34.80	8.80
350MCM	1/2	Brown	28.40	18.30	107.90	48.30	38.60	9.90
400MCM	1/2	Green	30.20	19.30	118.80	58.40	40.80	10.60
500MCM	5/8	Pink	33.50	21.30	120.60	63.50	45.40	11.90
600MCM	1/2	Black	36.60	23.30	130.00	65.00	49.70	12.90
750MCM	5/8	Yellow	40.60	26.20	155.40	81.30	55.60	12.90
1000MCM	5/8	Brown	45.98	29.40	155.40	81.30	63.50	15.00

NOTE:

1) Many manufacturers use Color-Keyed connectors are banded by colored stripes or engraving to indicate location of die on connector for compression. **As shown above.**

2) Always refer back to latest codes (NEC) that govern best practices for conductor sizing and lug sizing.

Figure 4.5 – Compression Lug Connections, Single Conductors

Aluminum Conductors

Aluminum oxidizes quickly when exposed to the atmosphere. An oxidized layer is a poor conductor that could lead to thermal issues, production loss, or damage to the Power Assemblies Combiner Box & not recommended.

For Reference:

NFPA Code - Table 310.16

Ampacities of Insulated Conductors with Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried)

NFPA Code – Table 310.4

Temperature Rating of Conductor

National Electrical Code (NEC)

The National Electrical Code, or NFPA 70, is a regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States.

STEP 5: Equipment Ground Wire Connections

Terminals are provided in the Power Assemblies 1500-400 Combiner Box for all equipment associated with the PV Source Circuits. Torque each EGC for the PV Source Circuits per the specifications below.

Ground Lug Provided within each Power Assemblies Combiner	DETAILS:
	• 15 position • 4 – 14 AWG • Copper • 90°C Rating • Torque Tightening: 20 lb.in, AWG 14...AWG 10, copper 25 lb.in, AWG 14...AWG 12, copper • Flat-head screwdriver

Fig. 4.6 - Equipment Ground Terminals

Final Steps

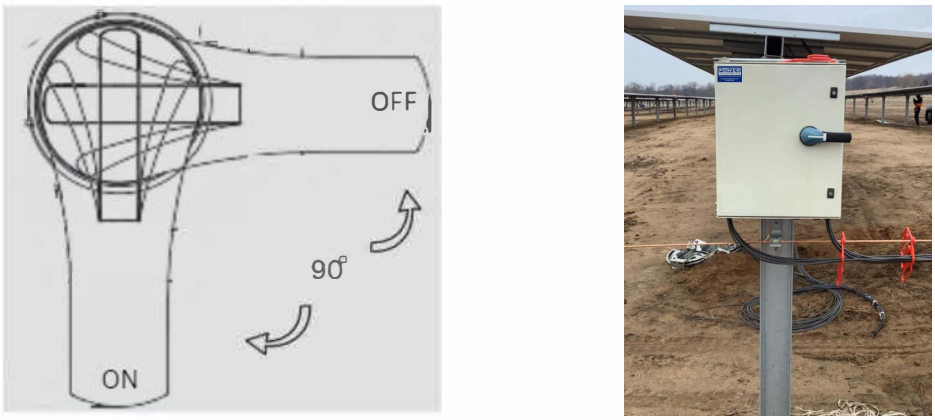
Verify the proper polarity of each conductor. Polarity reversal can lead to dangerous conditions capable of harming personnel and damaging equipment.

Check the Combiner for tools and debris; ensure that the unit is clean and orderly.

- ✓ Return the fuses to the fuse holders, but do not close the fuse into the fuse holder. Closing the fuse holders will be accomplished during system commissioning and start-up.
- ✓ Verify that all connections meet the requirements of this User's Manual.
- ✓ Secure the Power Assemblies 1500-400 Combiner Box cover, ensuring that both ¼-turn fasteners are fully secured.
- ✓ Consult the startup and commissioning procedures.

5. OPERATION

Do not operate the disconnect handle switch with the Combiner Box door open.



Travel of Handle **OFF Position**

Figure 5.1 – Switch Handle Positions for OFF (Right) and ON (Left)

The Power Assemblies 1500-400 Combiner Box contains a user-operable disconnect switch. When this disconnect switch handle is in the OFF position, the circuit is open between the ungrounded PV Source Circuit conductors and the ungrounded PV Output Circuit conductors. The disconnect handle can be locked in the OFF position with user-supplied safety locks. The plastic tab on the face of the disconnect handle can be lifted to reveal the locking provisions.

When the disconnect switch is in the ON position, the PV Source Circuit is closed between the ungrounded PV Source Circuit conductors and the ungrounded PV Output Circuit conductors.

The disconnect switch is rated for 400A, fully load-break rated and can be safely operated under normal operating conditions when installation is per this User's Manual and all warnings and ratings are observed.

⇨ All Disconnect Switches must be OFF before working on the Combiner Box.

Be Aware That Voltage Is Still Present on the Line Side (TOP) of the Switch, When the breaker is OFF and Fuses are still inserted into the fuse holder.

6. WARRANTY & RMA INSTRUCTIONS

For warranty information, please contact Power Assemblies.

7. APPENDICES

Appendix A – Contact Information

Power Assemblies - Nevada
915 E. Dale Avenue, Suite 100
Henderson, NV 89044
US (877)-597-5787

Power Assemblies - Florida
1650 NW 18th St, Suite 807A
Pompano Beach, FL 33069
US (866)-825-8525

Sales/General Info:

Sales@PowerAssemblies.com

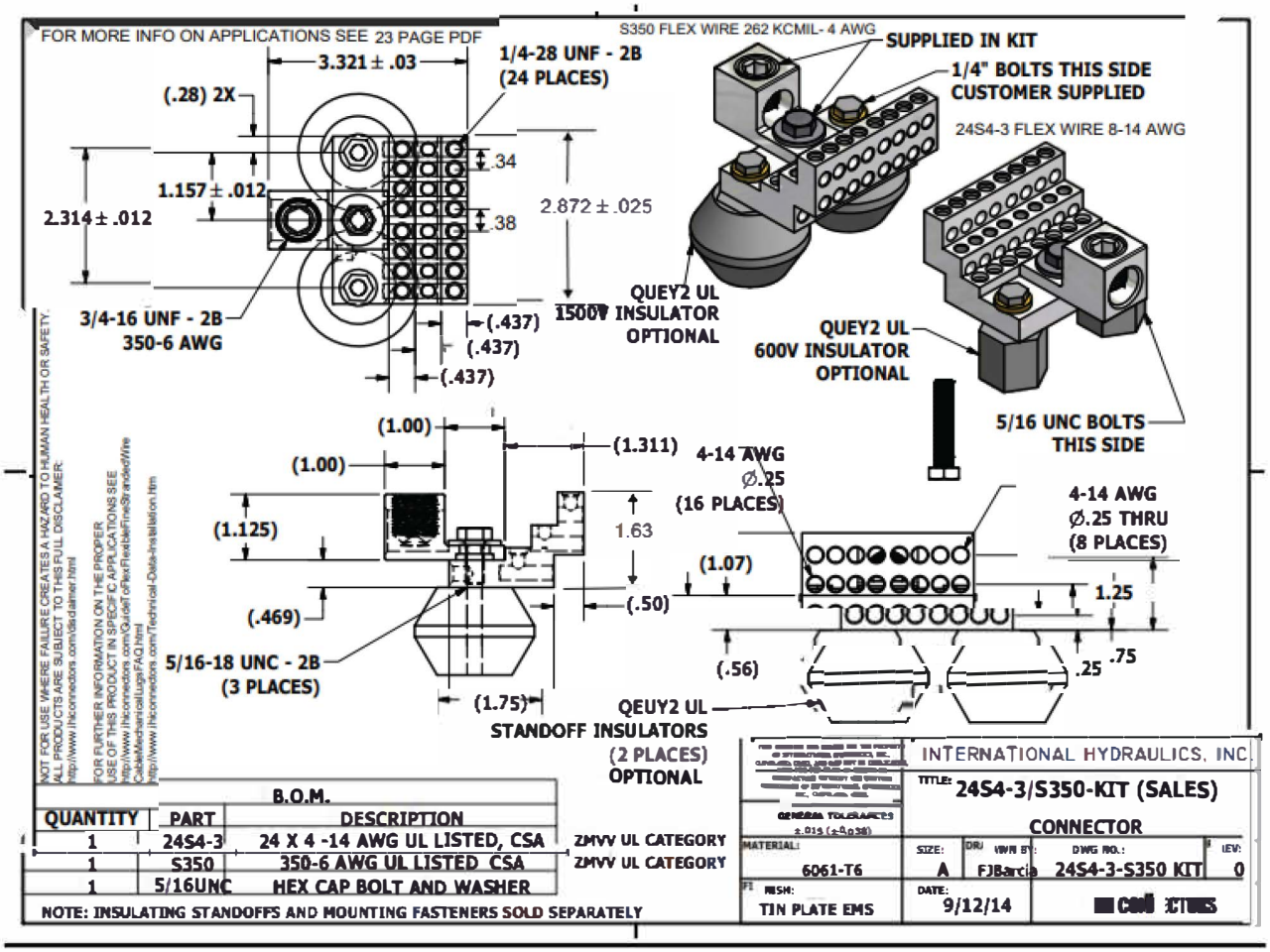
Customer Support: US (866)-825-8525

Website: PowerAssemblies.com

Appendix B - UL1741 Authorization to Mark

Appendix C – Negative Bus, 4 – 14AWG OPTION

For PV AWG wire sizes that connect to the negative bus that are 4 – 14AWG the following UL Connector Kit can be mounted on the negative bus.

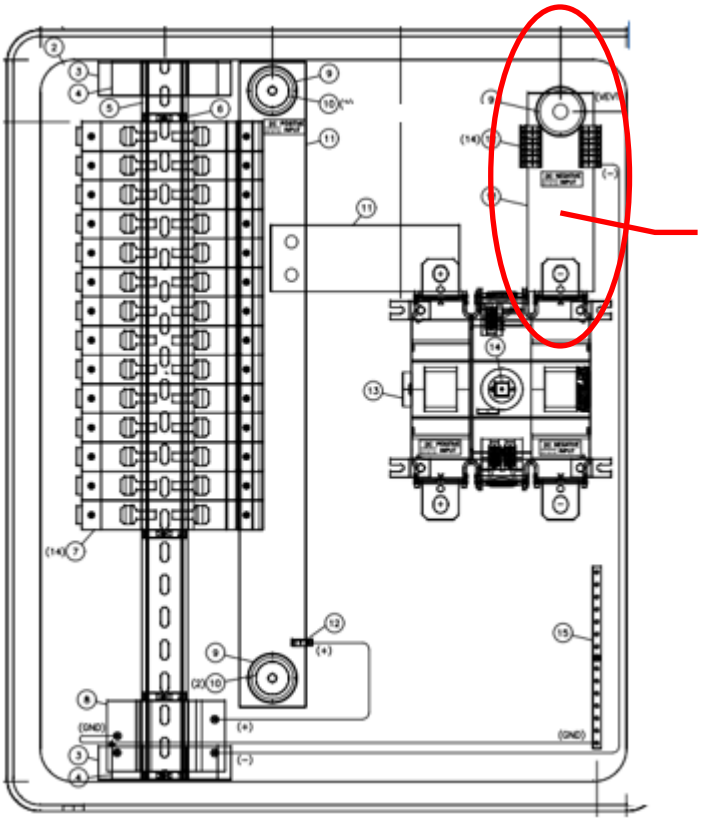


Procedure:

1) Remove the 14AWG negative bus conductor connectors from the negative bus

2) Mark the bus using the 2.314 spacing as shown above and drill negative bus bar .28 hole (x2) as shown, centering the 24S4 on the bus bar

3) Use ¼" bolts, washer, lock washer, captive nut and torque as outlined in the installation guide above.



Installation location of Lug Kit:
1) Centered on bus between the mounting lug of DC switch and the bolt to the stand off insulator

Tools Required:
2) Drill with .28 drill bit, ¼" bolts and hardware as described, torque wrench

Recommended Torque:

GRADE 8 Coarse Thread			
Size	Clamp Load	Plain (ft. lbs.)	Plated (ft. lbs.)
1/4-20 (.250)	2850	12	9

GRADE 8 Fine Thread			
Size	Clamp Load	Plain (ft. lbs.)	Plated (ft. lbs.)
1/4-28 (.250)	3263	14	10

Check the Combiner for tools and debris; ensure that the unit is clean and orderly.

COMBINER BOX - PART NUMBER SCHEMA

COM	-	XX	XX	XX
PRODUCT PREFIX		AMPERAGE	STRINGS	CAM DEGREE
		04 400A	12 12 Strings	15 1500 Vdc
		05 500A	13 13 Strings	10 1000 Vdc
		6 800A	14 14 Strings	
			15 15 Strings	
			16 16 Strings	
			17 17 Strings	
			18 18 Strings	
			19 19 Strings	
			20 20 Strings	
			21 21 Strings	
			22 22 Strings	
			23 23 Strings	
			24 24 Strings	
			25 25 Strings	