



# Barcelona Breaker Box Owner's Manual





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*This entire manual is printed without color but is available for download—with many of the diagrams available in color—on our website at [midnitesolar.com](http://midnitesolar.com).*



## INTRODUCTION

The Barcelona Breaker Box is a DC enclosure offering over-current protection (OCP) and disconnects between the PV array input to a charge controller, and OCP and disconnect from the charge controller to the battery bank. The Breaker Box is designed specifically for the MidNite Solar Barcelona 600V MPPT charge controller but may be used with any charge controller up to 600VDC/30A IN and 80VDC/200A OUT. The Barcelona charge controller will operate WITHOUT the optional Breaker Box.

### Standard Features:

- Terminal blocks to attach optional MidNite Solar Surge Protection Devices
- Two 600VDC, 30A, 3-pole, PV input circuit breakers with Remote-trip
- Styled to match the Barcelona 600V MPPT Charge Controller
- 80VDC, 200A, battery positive circuit breaker
- Optional backplate for mounting
- Ground busbar
- ETL Listed

**Pre-Wired Barcelona and Barcelona Breaker Box with backplate and Surge Protection Devices.**





## IMPORTANT SAFETY INSTRUCTIONS SAVE THESE INSTRUCTIONS

**THIS MANUAL CONTAINS IMPORTANT INSTRUCTIONS FOR THE MIDNITE SOLAR BARCELONA BREAKER BOX THAT SHALL BE FOLLOWED DURING INSTALLATION AND OPERATION.**

If you do not fully understand any of the concepts, terminology, or hazards outlined in these instructions, please refer installation to a qualified dealer, electrician, or installer. These instructions are not meant to be a complete explanation of a renewable energy system. Before using the Barcelona Breaker Box, read all instructions and cautionary markings. The installation instructions are for use by qualified personnel only. Do not perform any installation other than that specified in this manual unless you are qualified to do so. Incorrect installation may result in a risk of electric shock, fire, or other safety hazard.

### Safety Symbols

The following safety symbols have been placed throughout this manual to indicate dangerous and important safety instructions.

#### **WARNING!**

**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.

#### **CAUTION!**

**CAUTION** indicates conditions or practices that could result in damage to the unit or other equipment.

**INFO:** Indicates information that emphasizes or supplements important points of the main text.

### SAFETY PRECAUTIONS

- System grounding is the responsibility of the system installer and must comply with local and national electrical codes and standards.
- This product is designed for indoor/compartments installation. It must not be exposed to rain, snow, moisture, or liquids of any type.



- Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.
- Over-current protection of the DC wiring must be provided as part of the system installation.
- All electrical work must be performed in accordance with local and national electrical codes.
- Use insulated tools to reduce the chance of electrical shock or accidental short circuits.
- Use Class 1 wiring methods for field wiring connections to terminals of a Class 2 circuit.
  - Barcelona Class 2 terminals: WBJr, AUX, Current Transformers, BTS, CANBUS.
- The DC negative conductors are not connected (bonded) to the Barcelona chassis.
- Always verify proper wiring prior to energizing the Barcelona and Breaker Box.
- Torque all wiring and cable connections to the required torque values.
- Use only copper wires with a minimum temperature rating of 90°C.
- Properly mount the Barcelona and Breaker Box.
- Battery cables should be no less than **#2/0 AWG**.

## BATTERY SAFETY

- Wear eye protection and avoid touching your eyes and face when working with batteries to keep any fluid/corrosion on the battery from contact with eyes and skin. Have plenty of fresh water and soap nearby and thoroughly wash in case battery acid contacts skin, clothing, or eyes. In the event of exposure to the eyes, flood them for at least 15 minutes with running water and seek immediate medical attention. Baking soda neutralizes lead acid battery electrolyte and vinegar neutralizes spilled NiCad and NiFe battery electrolyte; depending on your battery type, keep a supply on hand near the batteries.
- Read and follow the battery manufacturer's safety precautions before installing the inverter and batteries. Always verify proper polarity and voltage before connecting the batteries to the Barcelona and Breaker Box. Once the batteries are connected, ensure the maintenance and charging requirements (i.e., charge voltage and charge rate) provided by the battery manufacturer are followed to extend the life of the batteries and to prevent damage to the batteries while charging.
- The battery bank should be installed in a clean, dry, ventilated environment that is protected from high and low temperatures. If installed in a vehicle/boat, the batteries must be mounted upright (if using liquid batteries) and securely fastened. The location must be fully accessible and protected from exposure to heat producing devices, and away from any fuel tanks.
- Batteries can produce explosive gasses, so install batteries in a well-ventilated area. For compartment or enclosure installations, always vent batteries from the highest point to the outside. Design the battery enclosure to prevent accumulation and concentration of hydrogen gas in pockets at the top of the compartment.



- Remove all jewelry such as rings, watches, bracelets, etc., when installing or performing maintenance on the batteries and inverter. A battery can produce a short-circuit current high enough to weld metal jewelry, causing severe burns.
- Use insulated tools and be very careful when working around batteries, they can produce extremely high currents if short-circuited (e.g., dropping a metal tool across the battery terminal), which could cause a fire or explosion.
- To prevent a spark at the battery and to reduce the chance of explosion, turn off (open) the DC battery breaker before attempting any wiring connections.
- Never work alone. Always have someone within the range of your voice or close enough to come to your aid when working around batteries.
- Never use old or untested batteries. Check each battery's label for age, type, and date code to ensure all batteries are identical.
- Batteries are sensitive to changes in temperature. Install batteries in a stable environment.
- Provide at least one inch of air space between batteries to provide optimum cooling.
- Use proper lifting techniques when working with batteries.
- Never smoke or allow a spark near batteries.
- Never charge a frozen battery.

## STANDARDS

The MidNite Solar Barcelona Breaker Box conforms to *UL 1741, Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, UL 1741:2010 Ed.2+R:15Feb2018; CSA C22.2#107.1:2016 Ed.4.*

## HOW TO **KILL** YOUR BATTERIES

Batteries are delicate and require proper attention, especially when off-grid. Think of your batteries and solar equipment as a small nuclear power plant, hydro dam, or natural gas-fired power plant. Just like any of those, your system needs DAILY attention to ensure it is performing correctly and safely. We recommend the use of an independent battery monitor/alarm if you have an expensive battery bank. Below is a list of some of the most common ways we have seen people kill their battery bank.


- Using more than three parallel strings and not using common bus bars. With lead-acid batteries, when you use more than three strings, it is very hard to properly charge the middle strings. The only safe way to do this is to wire each string with equal length cables to a common bus bar. Connect inverter cables to the farthest points on the busbars.
- Not watching to verify the Absorb or EQ times are set properly and that the equipment actually charges for that period of time. Some equipment will have settings like "End Amps" that can terminate Absorb early and, if set up wrong, can damage a battery.
- Not using ALL EQUAL LENGTH interconnect cables on each string. It is important that ALL strings be wired EXACTLY the same. Any variance in resistance on one string versus another



will cause an imbalance and the batteries will suffer a shortened lifespan.

- Trusting a State of Charge (SOC) meter, which can lose calibration over time and give you false readings. You need to verify specific gravity and or verify the charge voltage is being met. Never fully rely on the SOC %; it is just a good, quick reference.
- Routinely using more than 50% of the capacity of the lead acid battery. Using more than half the battery capacity drastically shortens the batteries life; occasionally is fine, but daily will kill lead acid batteries in months.
- Not leaving ample space between cells for cooling. We recommend at least one inch between the cells for cooling. Ask the battery manufacturer what they recommend.
- Not having enough charge current to properly charge the size of the battery you have. Consult the battery manufacturer for the minimum charge current.
- Using tap water or other liquids instead of distilled water in a flooded battery. The minerals in the tap water will destroy a battery.
- Not verifying the temperature compensation neutral point (typically 25°C) and the milli volts per degree C per cell (typically -5mV).
- Not verifying you are charging to the voltage supplied by the battery manufacturer.
- Not fully charging your lead acid batteries at least once a week.
- Failing to keep all connections clean.

## WIRING REQUIREMENTS

- The NEC (*National Electric Code, ANSI/NFPA 70*) for the United States and the CEC (*Canadian Electrical Code*) for Canada provide standards for safely wiring residential and commercial installations. The NEC/CEC lists the requirements for wire size, over-current protection, and installation methods.
- Do not mix AC and DC wiring in the same panel unless specifically approved/designed for both AC and DC wiring. Where DC wiring must cross AC or vice-versa, try to make the wires at the crossing point perpendicular (90 degrees) to one another.
- DC wires to and from the Barcelona must be protected as required by code. This can be done by using jacketed wires or by feeding the wires through conduit or a conduit box. The Barcelona Breaker Box satisfies this requirement.
- Always check for existing electrical, plumbing, or other areas of potential damage prior to making cuts in structural surfaces or walls.
- Wiring should meet all local codes and standards and be performed by qualified personnel such as a licensed electrician.
- DC over-current protection must be provided as part of the installation.
- Use only copper wires with a minimum temperature rating of 90°C.
- The equipment ground is marked with this symbol: 



## CAUTION!

The Barcelona and Breaker Box are designed for indoor installation with adequate ventilation. It must not be exposed to rain and should be installed out of direct sunlight.

## WARNING!

Ensure all sources of DC power (i.e., batteries, solar, wind, or hydro) are **OFF** – breakers opened, fuses removed – before proceeding to prevent accidental shock.

## DC Wiring

- Minimize the number of connections between the Barcelona, the Breaker Box, and the battery bank. Exceptions are the DC breaker —required at the battery to protect the DC wiring—in the positive line, and a DC shunt—to allow battery charge state monitoring—in the negative line. Additional connections will contribute to voltage drops, and these extra connection points may loosen during use.
- The DC cables/wires must be color coded with colored tape or heat shrink tubing: RED for positive (+); WHITE for negative (-) if solidly grounded or BLACK if using a GFP breaker; and GREEN for DC ground.
- Use the correct DC cable and corresponding circuit breaker to achieve maximum efficiency from the system and reduce fire hazards associated with overheating.
- The DC cables must be fine strand, super flexible, such as Cobra cable (or equivalent) and be approved for residential wiring per the NEC (THHN for example).
- Do not use the Barcelona chassis in place of the battery negative connection for grounding. A reliable return path directly to the battery is required.
- A readily accessible battery disconnect is required and must be located within sight of the battery system (NEC 480.7).
- Ensure cables have a smooth bend radius and do not become kinked.
- Ensure both DC cables pass through the same knockout and conduit to allow the inductive currents to cancel.
- Wiring to battery terminals should be checked once a month for proper tightness.
- Limit cable length to 6' or less from Barcelona Breaker Box to battery bank.
- **The battery bank voltage MUST be 48V!** Use **#2/0 AWG** battery cables.

**Installations should be performed by a licensed or certified electrician. It is the installer's responsibility to determine which safety codes apply.**



## DC Over-Current Protection

- The NEC requires both over-current protection (UL489 standards) and a disconnect switch. If a circuit breaker is used as the over-current protection device, it can also be used as the required DC disconnect.
- The DC over-current protection device must be installed on the positive DC cable. It must be correctly sized according to the size of DC cables being used, which means it is required to open before the cable reaches its maximum current carrying capability.

## Grounding

- The negative battery conductor should be solidly bonded to the grounding system at only one point in the system. The size for the conductor is determined by the size of the largest phase conductor, per the NEC/CEC.

**NOTE** – If using the optional ground fault (GF) toroid in the Barcelona, the battery can be solidly grounded.



Figure 1

- **Figure 1** shows the Barcelona equipment ground terminal.
- **Figure 2** shows the Ground busbar in the Breaker Box.
- Use **#6 AWG** (or larger based on grounding system design) ground electrode conductor.

**Arc Fault** - The NEC requires a PV system DC circuit operating at 80VDC or greater must be protected by an arc fault (AF) circuit interrupter.

**Ground Fault** - Since 2008 the NEC requires a DC Ground Fault (GF) Protection device on all PV systems to indicate when a GF condition exists.

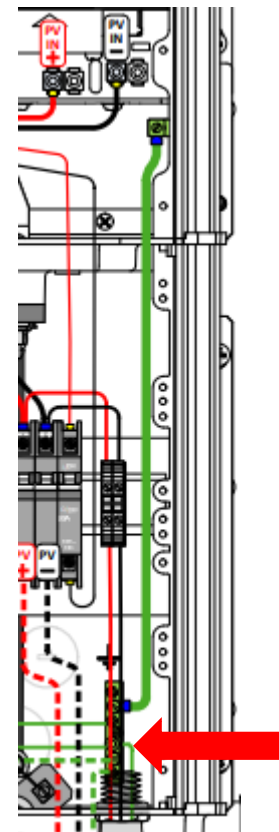


Figure 2

### CAUTION!

The Barcelona may be used in a positive, negative, or ungrounded installation. For a grounded system, bond either Battery Negative to ground, or bond Battery Positive to ground (but not both at the same time!!).



## INSTALLATION

Before installing, read the entire installation section to determine how you are going to install your Barcelona and Barcelona Breaker Box. The more thoroughly you plan in the beginning, the better your overall system needs will be met.

The installation begins by selecting a wall. The Barcelona and Breaker Box are indoor rated and should not be placed outside unless precautions are taken to keep rain and moisture off the system.

The NEC requires 30" clear on the wall. The Barcelona and Breaker Box may be located anywhere within this 30". The NEC also requires 36" free and clear of obstructions in front of the charge controller. The 36" clear area in front of all electrical panels is to provide a space to fall back into in case of electrical shock.

### Mounting Location

Install the Barcelona and Breaker Box in a location that meets the following requirements:

- Locate the Barcelona and Breaker Box as close to the batteries as possible. Long DC wires tend to lose efficiency and reduce the overall performance. However, the Barcelona should not be mounted where it will be exposed to gases produced by the batteries. Gases are corrosive and will damage the controller; also, if gases are not ventilated and if allowed to collect, they could ignite and cause an explosion.
- Ensure Barcelona is accessible after it is mounted. Control buttons are located on the front of the unit. You will need to access these buttons to program and monitor its operation.
- The Barcelona weighs 23 pounds. The Breaker Box weighs 12 pounds. The mounting surface and hardware must be capable of supporting at least twice the weight of these components.
- Mount at least 2' from any flammable or combustible fluid or components (i.e., paper, cloth, plastic, etc.) that may be ignited by heat, sparks, or flames.
- The area must be free from any risk of condensation, water, or any other liquid that can enter or fall on the Barcelona or Breaker Box.
- Mounted vertically on a flat, non-combustible surface.
- Plan any conduit runs now.

### Mounting – Barcelona and Breaker Box with Backplate

1. The optional backplate (**Figure 3**) makes installation easier.
2. Place backplate on wall at mounting location.
3. Mark holes for mounting hardware to hold backplate to wall.
4. Pre-drill pilot holes.

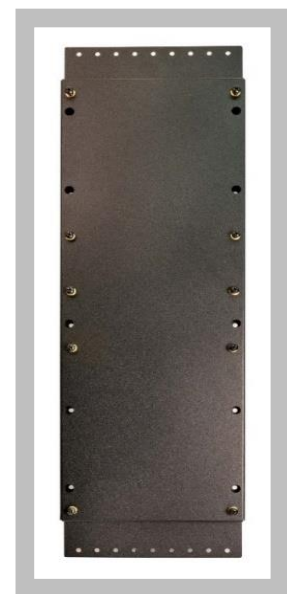


Figure 3



# MNBCLNA BB Manual

5. Lay backplate on workbench; attach Barcelona to backplate, aligning the keyholes (**Figure 4**) to the studs on the backplate; slide down into locking position.
6. Attach Breaker Box below Barcelona, aligning keyholes.
7. Wire Barcelona to the Breaker Box now (Page 12).
8. Mount the assembly to the wall using lag bolts.
9. Ensure mounting hardware is sufficient for the weight of the assembly and the mounting surface material.

**Be careful of the pre-installed wires in the Breaker Box when mating the Barcelona to the Breaker Box.**



Figure 4

## Mounting – Barcelona and Breaker Box without Backplate

1. Place Barcelona on wall at mounting location.
2. Mark holes for mounting hardware to hold Barcelona to wall.
3. Pre-drill pilot holes.
4. Based on mounting hardware, either:
  - a. Hold Barcelona to wall and install mounting hardware through the keyholes, or
  - b. Install top two mounting hardware bolts, then attach Barcelona, then install bottom two bolts.
  - c. Secure mounting hardware.
5. Repeat for Breaker Box:
  - a. Hold Breaker Box below Barcelona, be careful of pre-attached wires and busbars.
  - b. Ensure the Breaker Box is fully mated to the Barcelona.
  - c. Mark for holes, pre-drill.
  - d. Install mounting hardware and secure.
6. Ensure mounting hardware is sufficient for the weight of the assembly and the mounting surface material.
7. Wire Barcelona to Breaker Box, page 12.

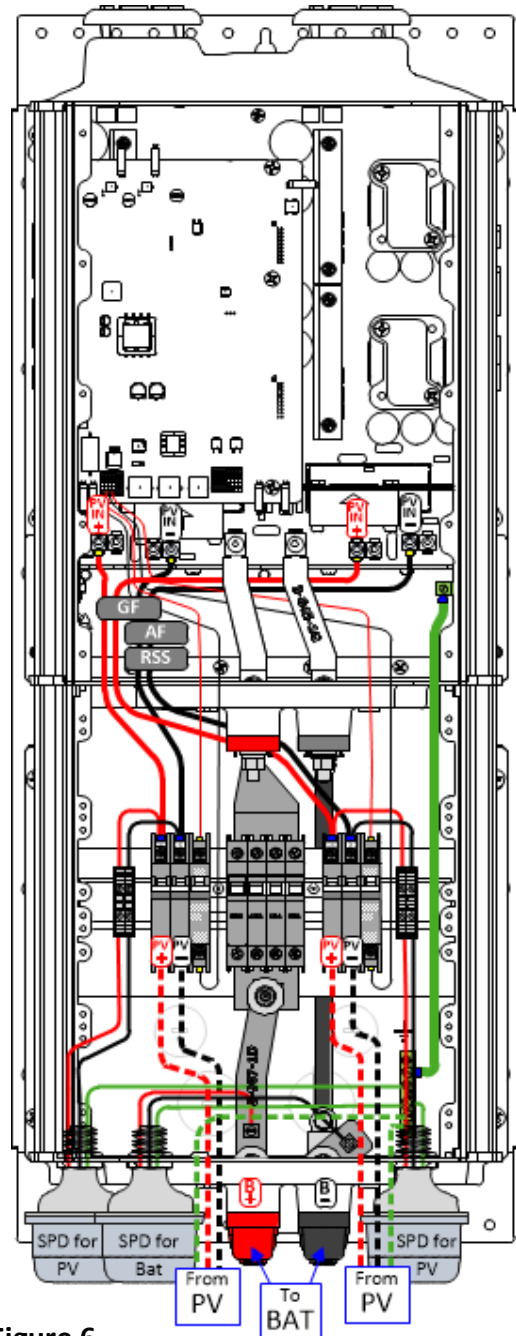


## BARCELONA & BREAKER BOX WIRING

Reference **Figures 5, 6, and 7** for an overview of a wired Barcelona and Breaker Box.

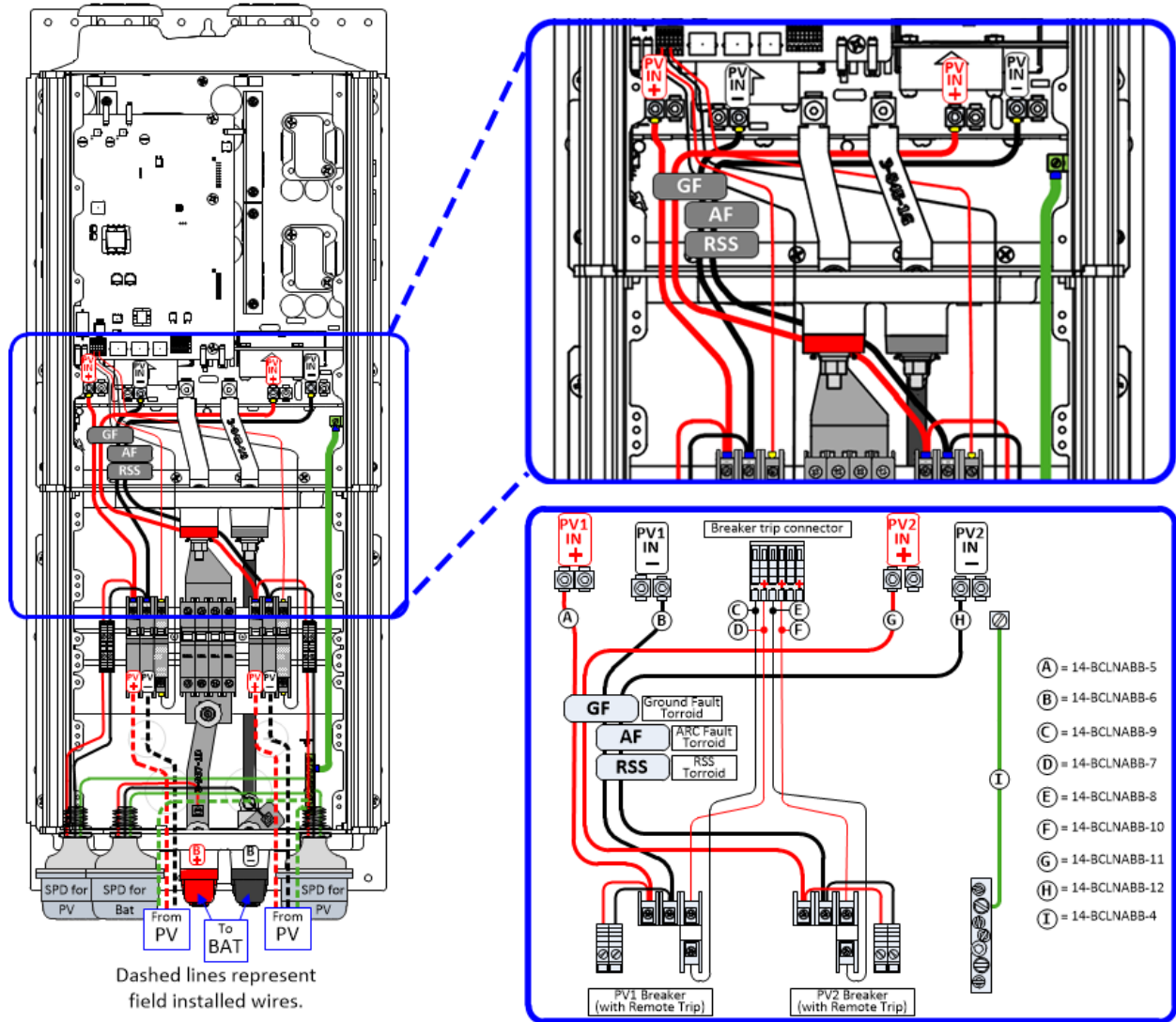


**Figure 5**



**Figure 6**

Dashed lines represent field installed wires.



**Figure 7**

## Pre-Installed Wiring (Figures 8, 9, 10, & 11)

### PV Breaker Trip Wires (Figures 8 & 9)

1. Ensure all breakers are off (down).
2. Raise the Barcelona's terminal block clamp levers (**Figures 8 & 9, #1**) marked "Breaker Trip."
3. Insert PV trip wires from both PV input breakers into the terminal block (**#1**). The terminal block has 3 ports, each marked with "+" and "-." You can use any 2 of the 3 terminals. Insert red wire to PV+ terminal; black wire to PV- terminal.
4. Securely fasten by pushing down on the block clamp levers.

## PV+ Wires (Figure 9)

1. Ensure all breakers are off (down).
2. Insert red PV+ breaker wire (#6) into the PV+ terminal block (#2).
3. Insert red PV+ breaker wire (#7) into the PV+ terminal block (#4).
4. Torque to 20 in-lbs.

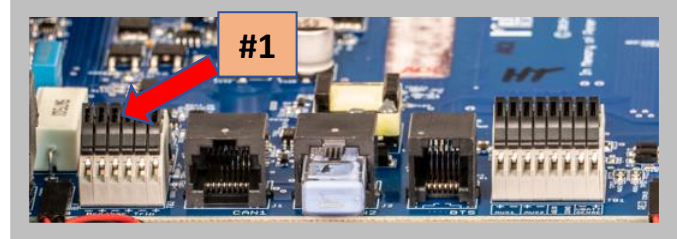


Figure 8

## PV- Wires (Figure 9)

1. Ensure all breakers are off (down).
2. Insert black PV- breaker wire (#6) into the PV- terminal block (#3).
3. Insert black PV- breaker wire (#7) into the PV- terminal block (#5).
4. Torque to 20 in-lbs.

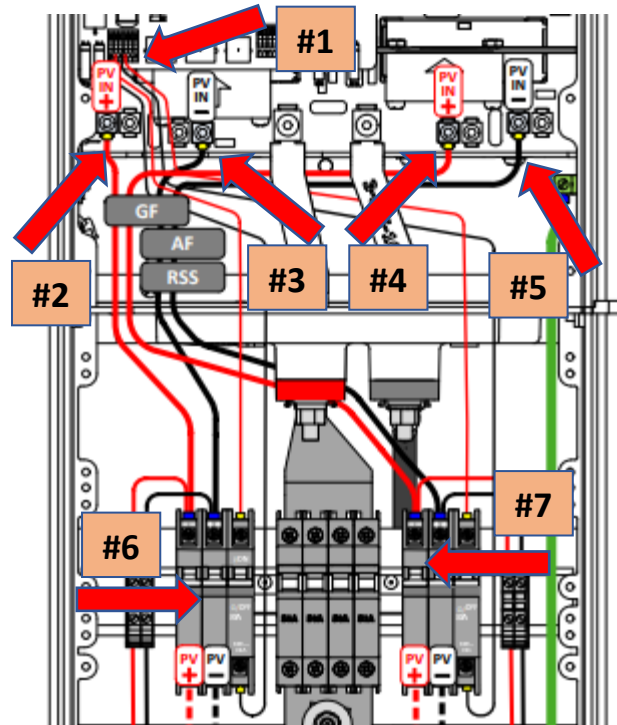


Figure 9

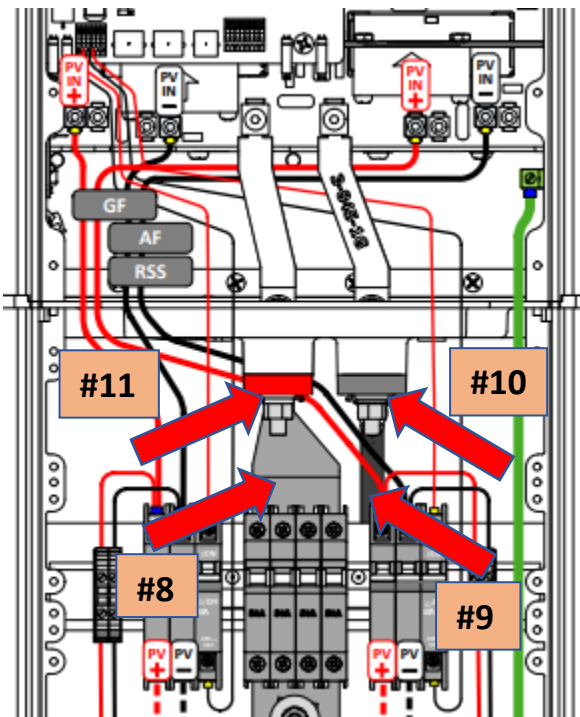


Figure 10

## Battery Connections (Figure 10)

1. Ensure all breakers are off (down).
2. (#8; Batt+ busbar) and (#9; Batt- cable) are pre-installed in the Breaker Box.
3. Attach Batt+ busbar (#8) to the Barcelona's Batt+ terminal (#11).
4. Attach Batt- cable (#9) to the Barcelona's Batt- terminal (#10).
5. Torque to 21 ft-lbs.

## Ground Wire (Figure 11)

1. Attach pre-installed **#6 AWG** ground wire (**#12**) to equipment ground terminal in Barcelona (**#13**).
2. Torque to 35 in-lbs.

## External Wiring (Figures 12 & 13)

### PV Array Wires (Figure 12)

1. Ensure all breakers are off (down).
2. Insert PV+ and PV- wires from PV array #1 into bottom of PV breaker (**#14**). PV+ on left; PV- on right of PV breaker.
3. Insert PV+ and PV- wires from PV array #2 into bottom of PV breaker (**#17**). PV+ on left; PV- on right of PV breaker.
4. If using wind or hydro, connect the DC+/- wires here.
5. Torque to 30 in-lbs.

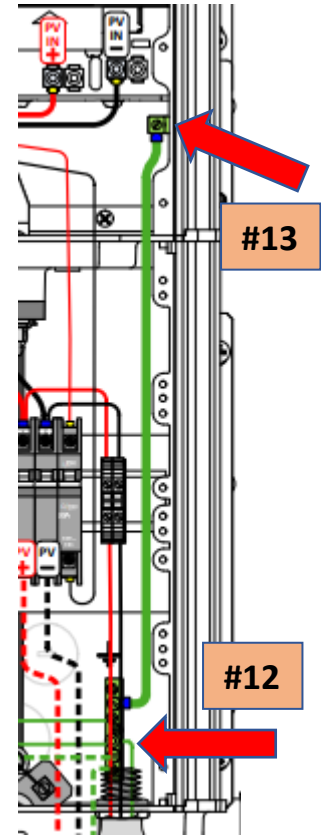


Figure 11

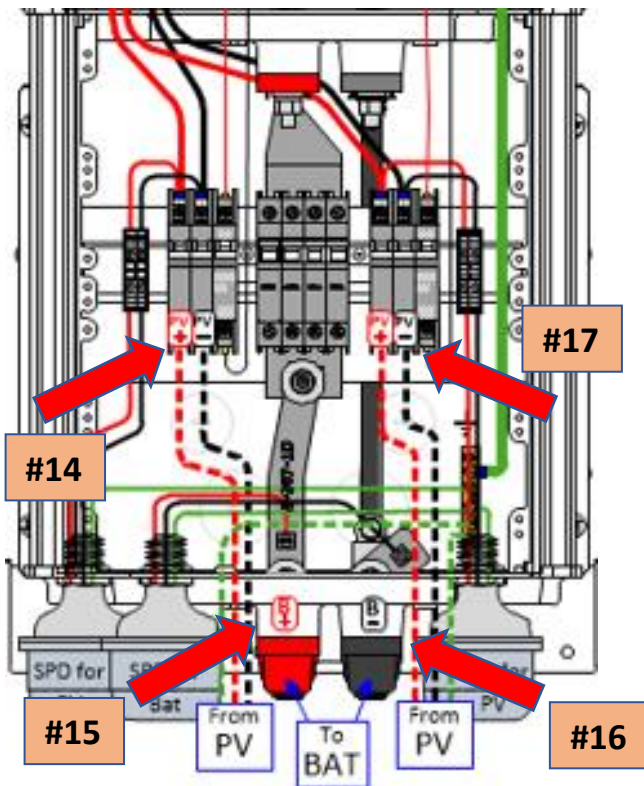


Figure 12

### Battery Cables (Figure 12)

1. Ensure all breakers are off (down).
2. Cut sufficient length of **#2/0 AWG** wire between (**#15**) and battery bank master positive terminal.
3. Crimp **#2/0 AWG x 5/16"** terminal lug onto one end of batt cable.
4. Attach Batt+ cable to Batt+ terminal (**#15**).
5. Crimp appropriate terminal lug onto other end; attach Batt+ cable to battery bank master positive terminal.
6. Repeat for Batt- cable, connect to (**#16**) and battery bank master negative terminal. Torque per battery specs.
7. Torque Breaker Box battery connections to 21 ft-lbs.

## PV SPD Wires (Figure 13)

1. Ensure all breakers are off (down).
2. Insert left PV SPD red wire to PV+ terminal block (#18).
3. Insert left PV SPD black wire to PV- terminal block (#19).
4. Insert right PV SPD black wire to PV+ terminal block (#20).
5. Insert right-side SPD red wire to PV- terminal block (#21).
6. Torque to 7 in-lbs.
7. Insert SPD green ground wires to Ground busbar (#22). Torque 20-30 in-lbs (using small setscrews).

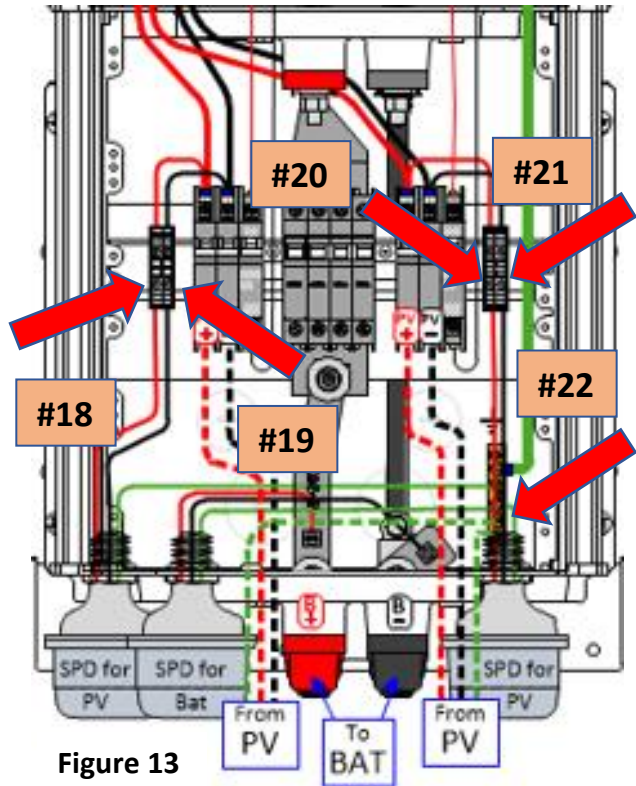


Figure 13

## Ground Electrode Conductor (Figure 13)

1. Cut sufficient length of **#6 AWG** ground (GEC) wire (or larger based on grounding system design) between (#22) and the ground rod.
2. Insert ground wire (GEC) at Breaker Box Ground busbar (#22) and at main ground busbar or ground rod, depending on the overall grounding system design.
3. Torque to 30 in-lbs (small screws); 45 in-lbs (large screws).

**The NEC or CEC may require a larger gauge Ground Electrode Conductor from (#22) to earth ground depending on grounding method. Check NEC/CEC.**





## ENERGIZING THE BARCELONA BREAKER BOX

Read and follow the information below and the procedural steps listed by number to properly energize and test the charge controller.

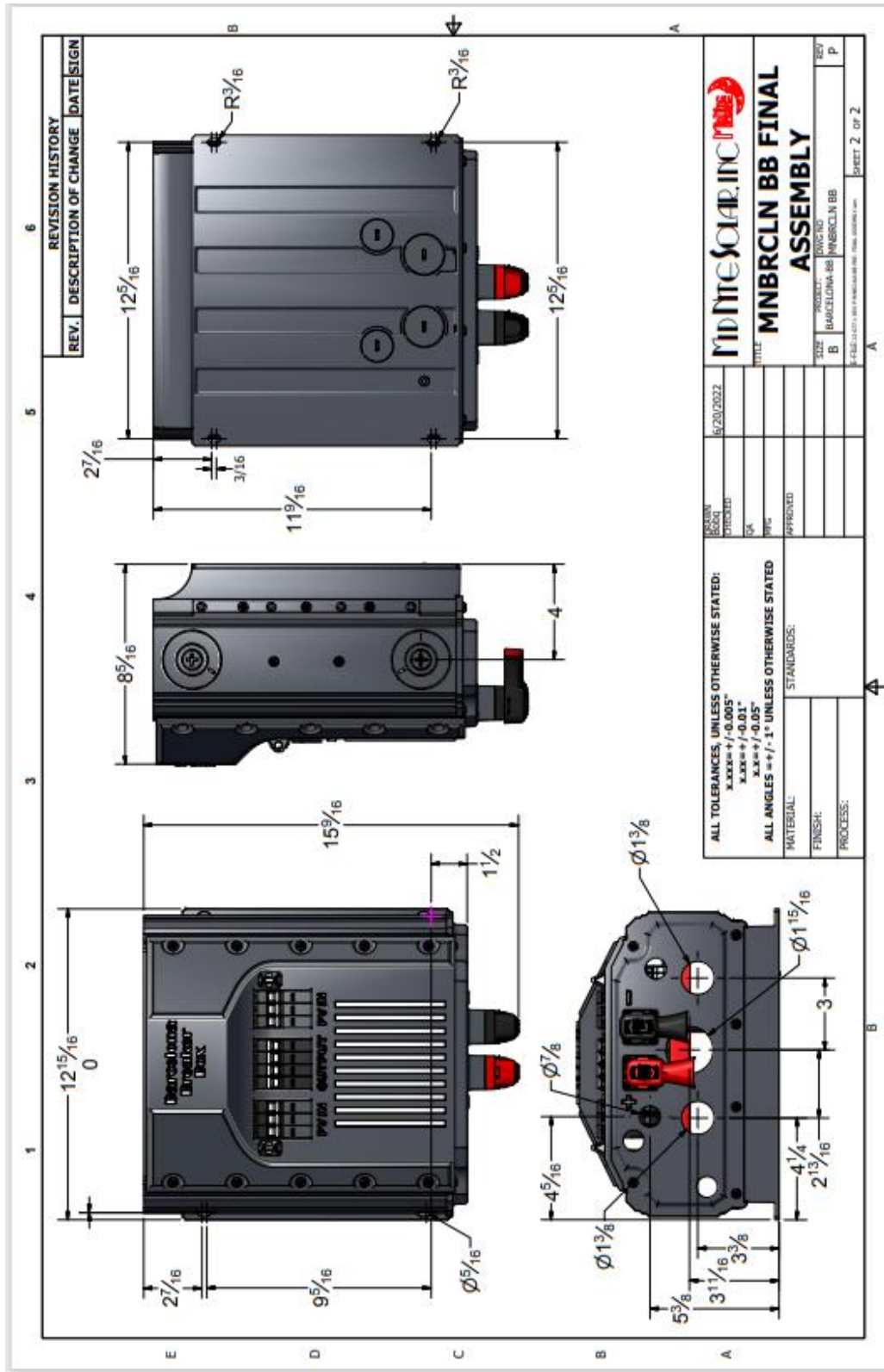
### Step #1 – Turn **OFF** all breakers

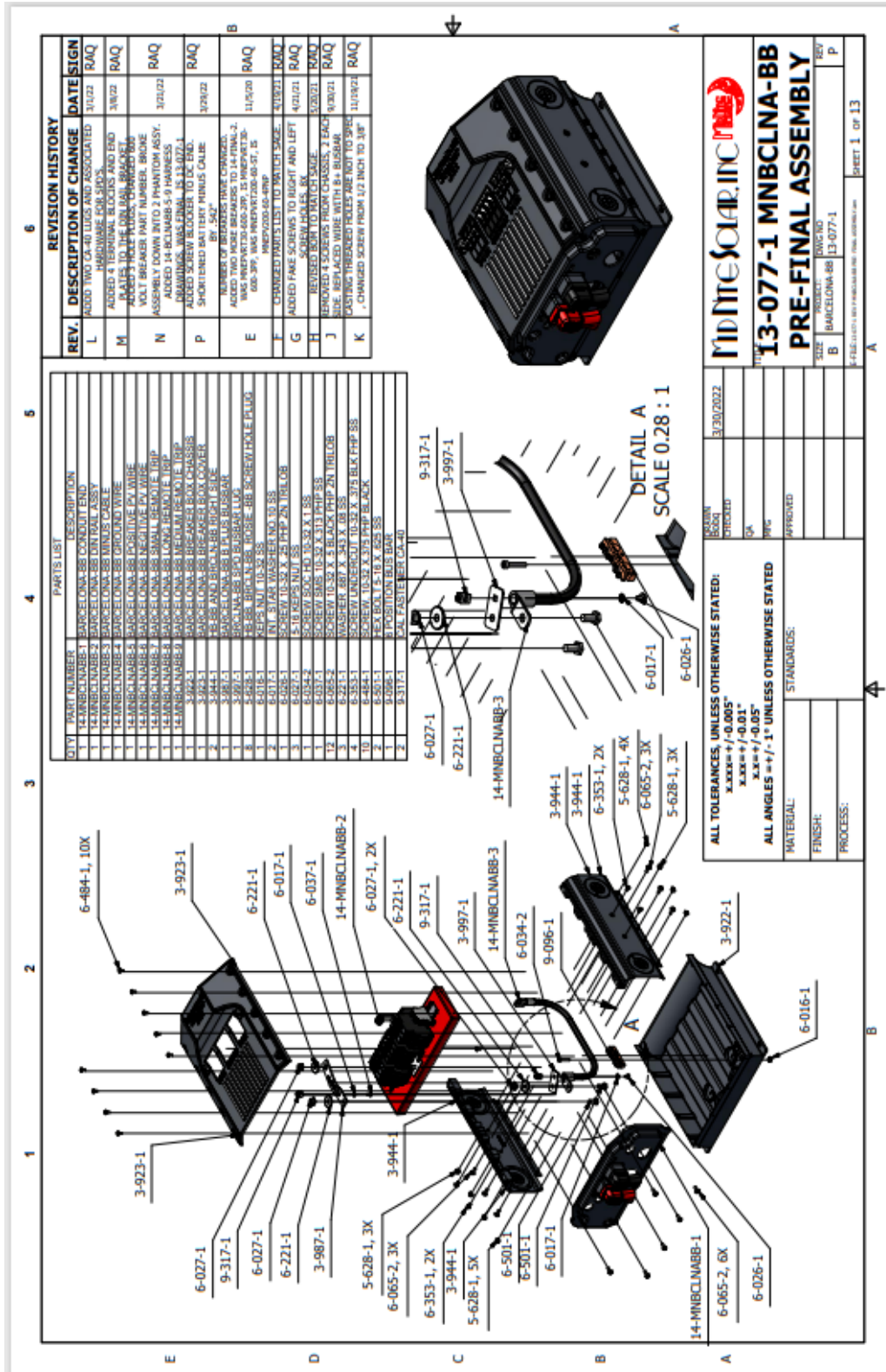
### Step #2 – Battery

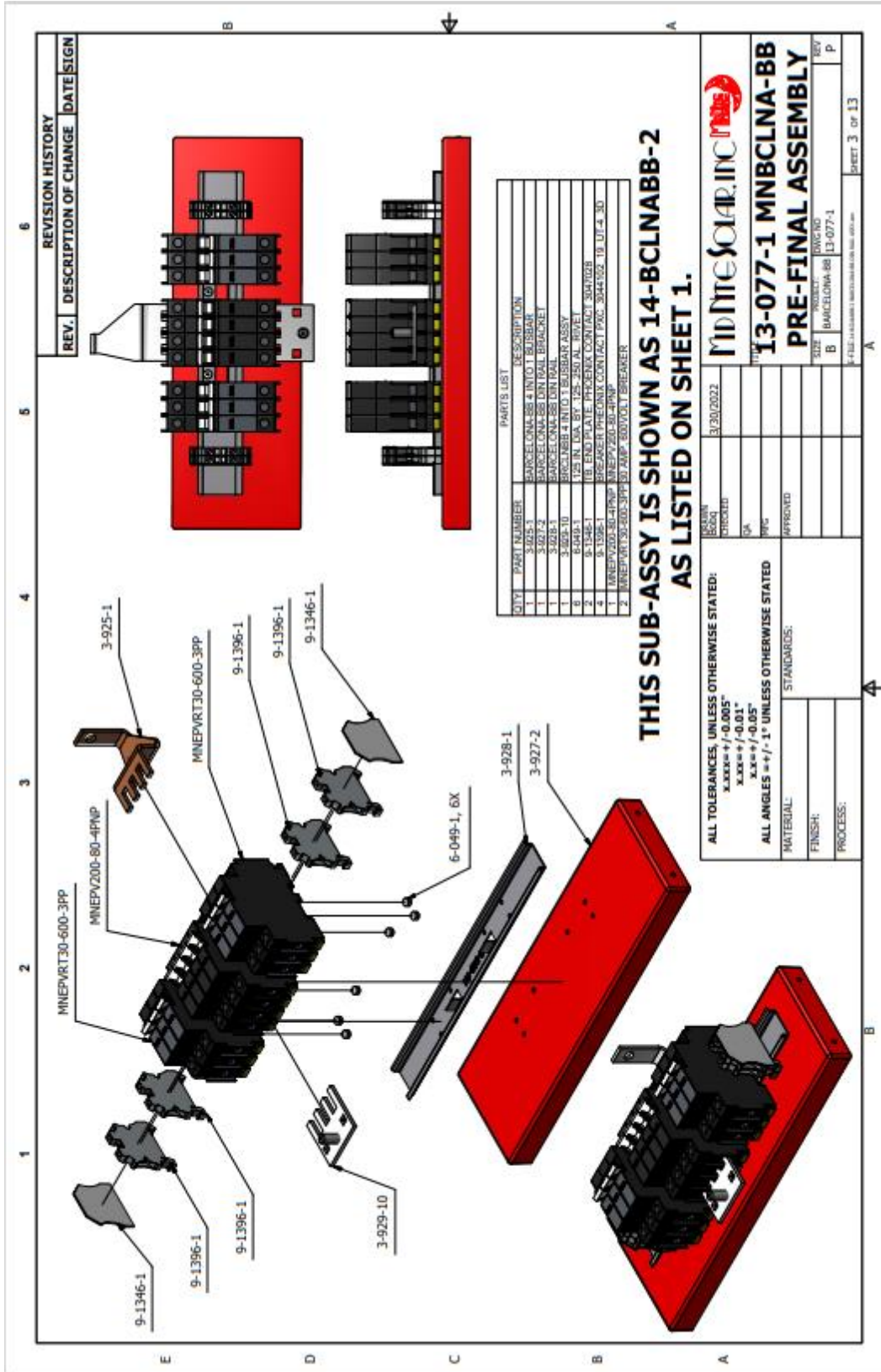
- **Voltmeter** – Measure for battery bank voltage between the Breaker Box Battery + breaker (at bottom of breaker) and the Barcelona Batt- terminal.
  - Battery bank voltage present?
    - **Yes** – Good (40-65VDC)
    - **No** – Check DC wiring/connections to the battery. Check batteries.
- Close Batt+ breaker.
- **Voltmeter** – Measure for battery bank voltage between the Barcelona Batt+ and Batt- terminals.
  - Battery bank voltage present?
    - **Yes** – Good.
    - **No** – Check DC wiring/connections or battery breaker.

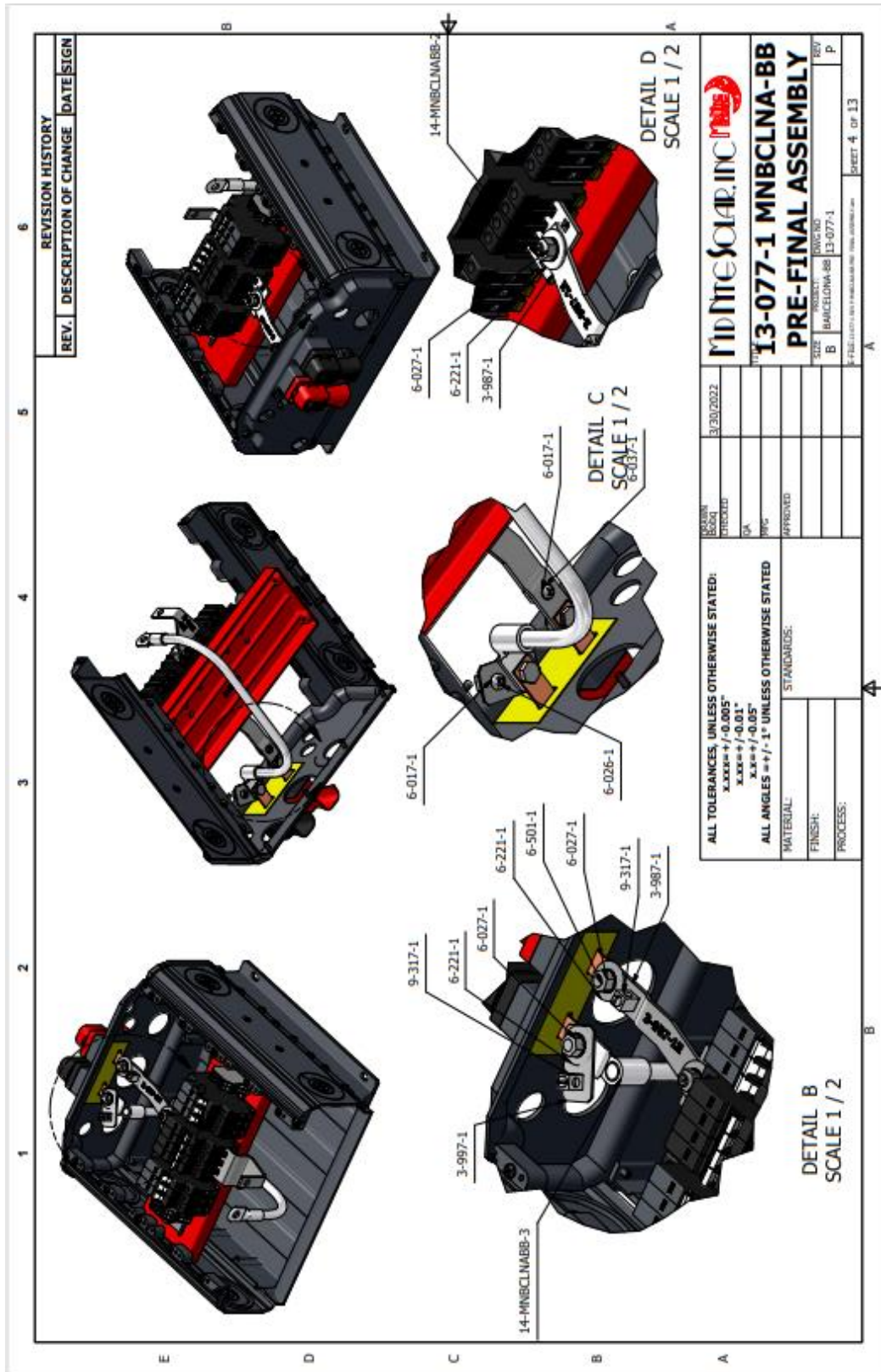
### Step #3 – PV

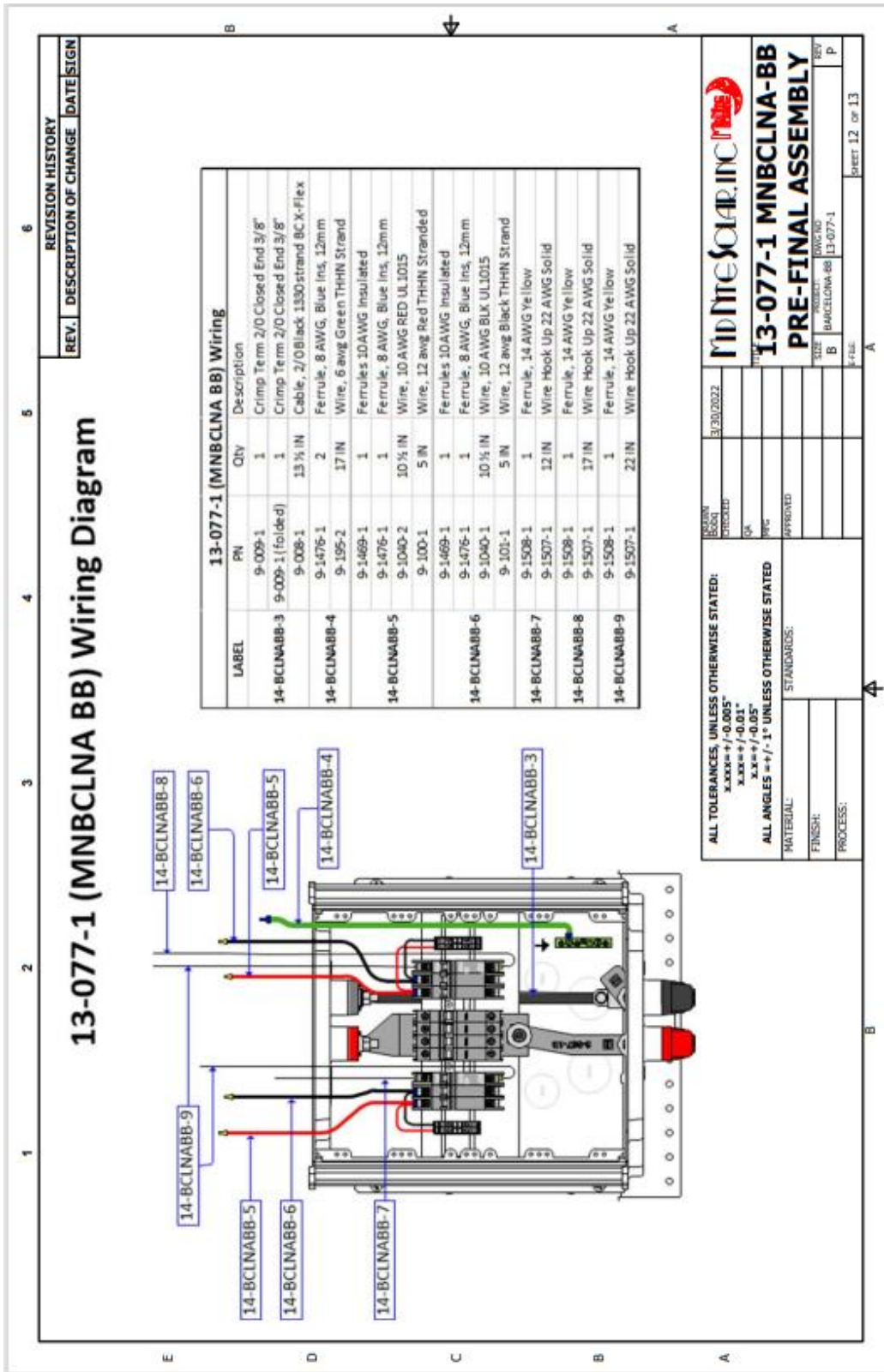
- Connect or turn on the PV/DC input (PV combiner – ON).
- Leave the Breaker Box PV breakers off.
- **Voltmeter** – Measure for PV (open-circuit) voltage between PV+ breaker (at bottom of breaker) and PV- breaker (at bottom of breaker).
  - PV voltage (Voc, open-circuit voltage) present?
    - **Yes** – Good (>240-550VDC)
    - **No** – Check PV combiner breakers, PV wiring, or connections.
- Turn on (close) the PV IN breakers.
- **Voltmeter** – Measure for PV voltage between Barcelona PV+ and PV- terminals.
  - PV voltage present?
    - **Yes** – Good
    - **No** – Check wiring, connections, or PV IN breaker(s).













## **MIDNITE SOLAR INC. LIMITED WARRANTY**

### **MidNite Solar Power electronics, sheet metal enclosures and accessories**

MidNite Solar Inc. warrants to the original customer that its products shall be free from defects in materials and workmanship. This warranty will be valid for a period of five (5) years.

MidNite Solar will not warranty third party inverter components used in MidNite's pre-wired systems. Those components are warranted by the original manufacturer.

At its option, MidNite Solar will repair or replace at no charge any MidNite product that proves to be defective within such warranty period. This warranty shall not apply if the MidNite Solar product has been damaged by unreasonable use, accident, negligence, service, or modification by anyone other than MidNite Solar, or by any other causes unrelated to materials and workmanship. The original consumer purchaser must retain original purchase receipt for proof of purchase as a condition precedent to warranty coverage. To receive in-warranty service, the defective product must be received no later than two (2) weeks after the end of the warranty period. The product must be accompanied by proof of purchase and Return Authorization (RA) number issued by MidNite Solar. For an RMA number contact MidNite Solar Inc., (360) 403-7207. Purchasers must prepay all delivery costs or shipping charges to return any defective MidNite Solar product under this warranty policy. Except for the warranty that the products are made in accordance with, the specifications therefore supplied or agreed to by customer:

MIDNITE SOLAR MAKES NO WARRANTY EXPRESSED OR IMPLIED, AND ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WHICH EXCEEDS THE FOREGOING WARRANTY IS HEREBY DISCLAIMED BY MIDNITE SOLAR AND EXCLUDED FROM ANY AGREEMENT MADE BY ACCEPTANCE OF ANY ORDER PURSUANT TO THIS QUOTATION. MIDNITE SOLAR WILL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES, LOSS OR EXPENSE ARISING IN CONNECTION WITH THE USE OF OR THE INABILITY TO USE ITS GOODS FOR ANY PURPOSE WHATSOEVER. MIDNITE SOLAR'S MAXIMUM LIABILITY SHALL NOT IN ANY CASE EXCEED THE CONTRACT PRICE FOR THE GOODS CLAIMED TO BE DEFECTIVE OR UNSUITABLE.

Products will be considered accepted by customer unless written notice to the contrary is given to MidNite Solar within ten (10) days of such delivery to customer. MIDNITE SOLAR is not responsible for loss or damage to products owned by customer and located on MIDNITE SOLAR'S premises caused by fire or other casualties beyond MIDNITE SOLAR'S control. This warranty is in lieu of all other warranties expressed or implied.

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