Off-Grid Kit

Renogy off-grid kit general Manual

RENOGY

THE FUTURE OF CLEAN ENERGY

2775 E. Philadelphia St., Ontario, CA 91761
1-800-330-8678

⚠ Important Safety Instructions ⚠

Please save these instructions.

Please read the instruction manual carefully before attempting to carry out any installation or wiring. Contact Technical support for any questions concerning the installation.

⚠ **WARNING: Indicates a potentially dangerous condition. Use extreme caution when performing this task.**

CAUTION: Indicates a critical procedure for safe and proper operation.

NOTE: Indicates a procedure or function that is important to the safe and proper operation.

Installation and wiring compliance

Installation and wiring must comply with the local and National Electrical Codes and must be done by a certified electrician. Please follow these four steps:

1. Read all of the instructions and cautions in the manual before beginning the installation.
2. It is HIGHLY recommended to install a charge controller in order to charge your batteries. It is dangerous for unregulated panels to be connected to battery banks.
3. Make sure all wire connections are secured; loose connections may cause sparks.
4. Wear appropriate clothing and safety gear including protective eyewear when performing any electrical installation.

Preventing fire and explosion hazards

Working with electronic/electrical equipment may produce arcs or sparks. Thus, such equipment should not be used in areas where there are flammable materials or gases requiring ignition protected equipment. These areas may include spaces containing gasoline-powered machinery, fuel tanks, and battery compartments.

Precautions when working with batteries

- Batteries contain very corrosive diluted sulfuric acid as electrolyte. Precautions should be taken to prevent contact with skin, eyes, or clothing.
- Batteries generate hydrogen and oxygen during charging, resulting in the evolution of an explosive gas mixture.

- Care should be taken to ventilate the battery area and follow the battery manufacturer's recommendations. Never smoke or allow a spark or flame near the batteries.
- Use caution to reduce the risk of dropping a metal tool on the battery. It could spark or short circuit the battery or other electrical parts and could cause an explosion.
- Remove metal items such as rings, bracelets, and watches when working with batteries. The batteries can produce a short circuit current high enough to weld a ring or similar object to the metal, causing a severe burn.
- If you need to remove a battery, always remove the ground terminal from the battery first. Make sure that all the accessories are off so that you do not cause a spark.
- Only use properly insulated tools when making battery connections.

Precautions when working with solar panels

With the incidence of sunlight or other light sources on all solar panels, a voltage appears at the output terminals of the solar panel turning it into a source of electricity. To avoid a shock hazard, make sure the solar panel is covered with an opaque (dark) material such as paper or cloth during the installation. Do not make contact with the terminals when the panel is exposed to sunlight or any other light source.

Precautions when working with charge controllers

If two or more solar panels are connected in a series/parallel make sure that the sum of the short circuit current ratings of all panel strings does not exceed 80% of the charge controller's current rating (i.e. 24A for the 30A charge controller). The open circuit voltage of the solar array (i.e. the maximum voltage across the array) should not exceed 26V when the 12V setting on the charge controller is used, and may not exceed 52V when the 24V setting on the charge controller is used.

Routine maintenance

- Inspect the solar panels and make sure the surfaces are free from dust, dirt, and other debris; clean with a wet cloth or glass cleaner if necessary.
- Check to make sure all structural components, mechanical fasteners, and electrical connections are secure, clean, and corrosion-free.
- Check and maintain the battery electrolyte levels at regular intervals as per the battery manufacturer's recommendations if flooded wet cell lead acid batteries are used.
- Check and replace damaged components if necessary.

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General Information

A new **RENOGY** Off-Grid Solar Kit will provide you with a clean, silent, and sustainable way of ensuring that batteries are fully charged and capable of providing a continuous supply of electricity. Each kit comes equipped with a high quality solar panel that features highly efficient silicon solar cells. If you have purchased a **RENOGY** Off-Grid Solar Kit, a PWM Solar Charge Controller is also included in the package. This controller will serve as a connector between the solar panel and the batteries. The solar charge controller will ensure that the battery is charged with the appropriate amount of solar power as per the battery manufacturer's recommendations. The solar charge controller 'charging states' are optimized to meet the requirements of most standard lead acid batteries as well as flooded batteries. The **RENOGY** Off-Grid Solar Kit also includes a mounting system comprised of sturdy aluminum Z-Brackets as well as the nuts and bolts required to flat mount a solar panel onto a roof or any other flat surface. If you wish to optimize your panel's collection of sunlight by tilting the panel to a different inclination, an adjustable tilt-mount may be purchased separately.

This manual will provide you with instructions on how to assemble the various components of a **RENOGY** Off-Grid Solar Kit. Please refer to the separate Renogy Solar Charge Controller Manual for detailed information about the installation, operation, and programming of the solar charge controller.

Please read the manual carefully before installing or operating the solar kit to prevent personal injury or damage to the components. If you have any concerns about the suitability of the kit for your application, or doubts about any of the instructions in this manual, please contact RENOGY Support at **1-800-330-8678**.

Charge Controller Installation

The RENOGY Starter and RV Kits come with a PWM- type charge controller to optimally charge your batteries from solar power. Each charge controller comes with a separate detailed manual. It is recommended that you read the solar charge controller manual in detail. The instructions in this section are only a brief summary of the information contained in the manual. Make sure the solar panels and batteries are disconnected from the charge controller before mounting the charge controller.

Recommended tools to have before installation:

Flathead Screwdriver	Multi-Meter
	

WARNING: Connect battery terminal wires to the charge controller FIRST then connect the solar panel(s) to the charge controller. NEVER connect solar panel to charge controller before the battery.

CAUTION: Do not over-torque or over tighten the screw terminals. This could potentially break the piece that holds the wire to the charge controller.

CAUTION: Refer to the technical specifications for max wire sizes on the controller and for the maximum amperage going through wires.

Mounting Recommendations:

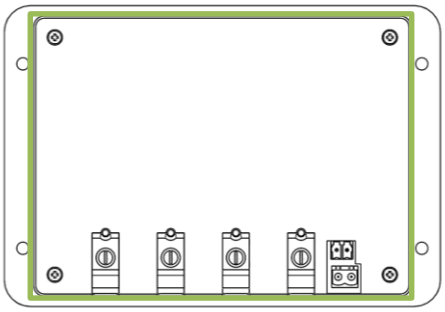
WARNING: Never install the controller in a sealed enclosure with flooded batteries. Gas can accumulate and there is a risk of explosion.

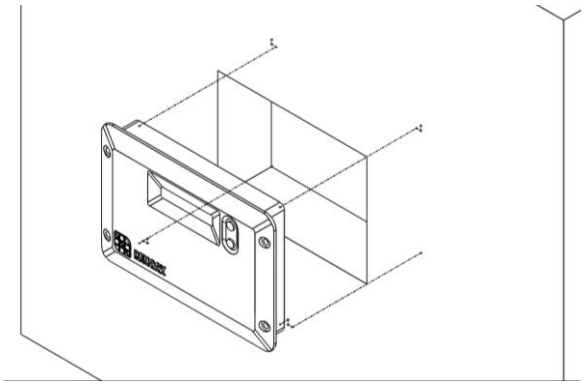
The Adventurer is designed for flush mounting on a wall. It consists of a face plate with projecting terminals on the backside for connecting the battery bank, panels, and optional sensors for accurate battery voltage sensing and battery temperature compensation. If utilizing the wall mount, then the wall will be required to be cut to accommodate the projecting terminals on the backside. Make sure that the pocket of the wall cut leaves enough space to not damage the terminals when the Adventurer is being pushed back into the cut out section of the wall.

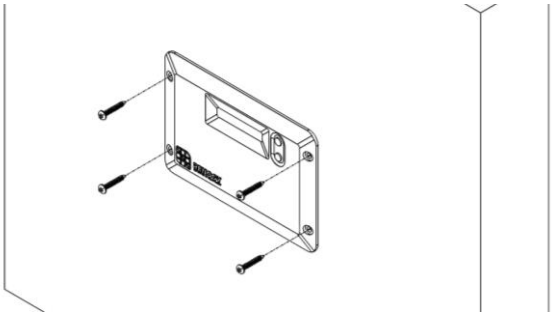
The front of the Adventurer will serve as a heat sink, therefore it is important to ensure that the mounting location is not near any heat generating sources and ensure that there is proper airflow across the faceplate of the Adventurer to remove the heat dissipated from the surface.

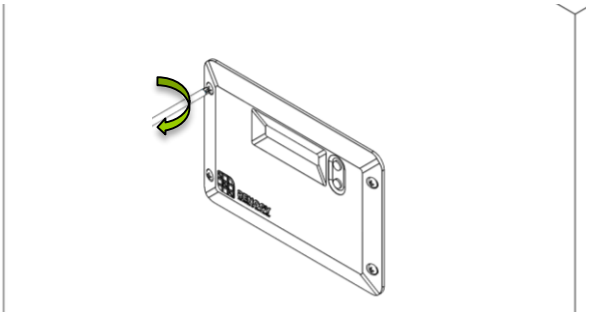
1. **Choose Mounting Location—**place the controller on a vertical surface protected from direct sunlight, high temperatures, and water. Make sure there is good ventilation.
2. **Check for Clearance—**verify that there is sufficient room to run wires, as well as clearance above and below the controller for ventilation. The clearance should be at least 6 inches (150mm).
3. **Cut out Wall section—**the recommended wall size to be cut should follow the inner protruding part of the charge controller while being careful not to go past the mounting holes. The depth should be at least 1.7 inches (43mm).
4. **Mark Holes**
5. **Drill Holes**

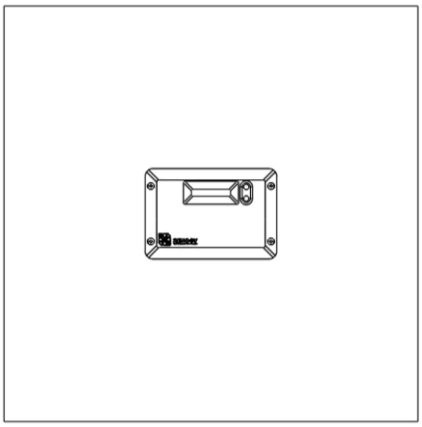
   NOTE: The Adventurer comes equipped with screws for wall mounting. If they are not suitable try ***using Pan Head Phillips Screw 18-8 Stainless Steel M3.9 Size 25mm length screws***.
6. **Secure the charge controller.**





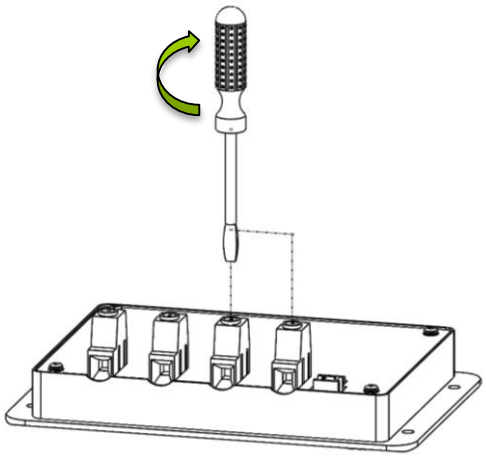


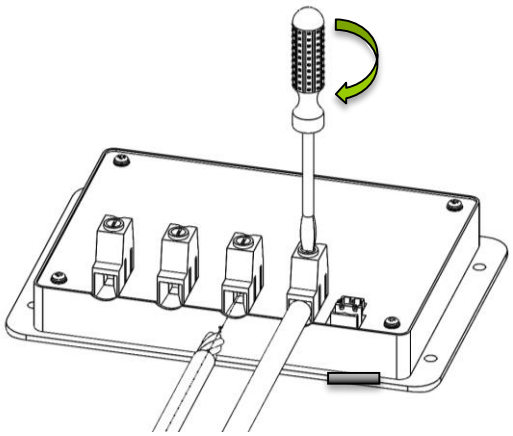


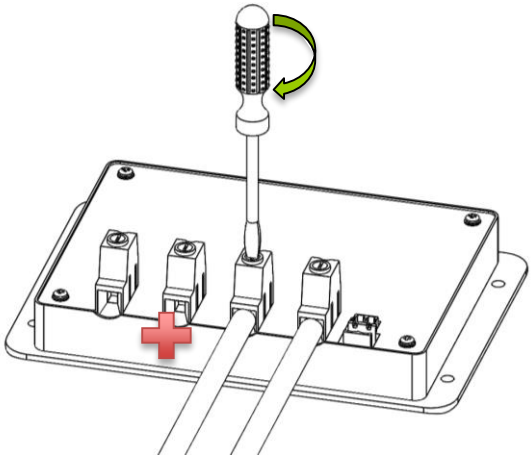


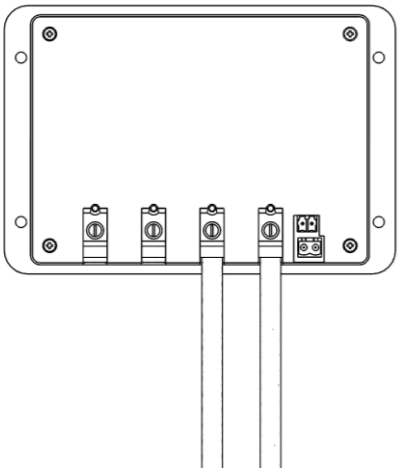
Wiring

1. **Unscrew battery terminals and connect battery connections**

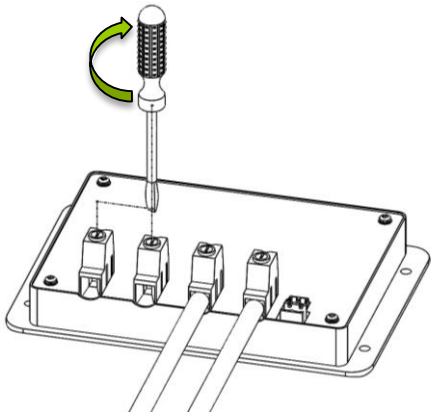


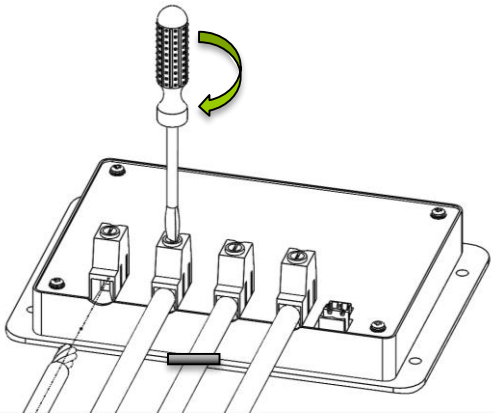


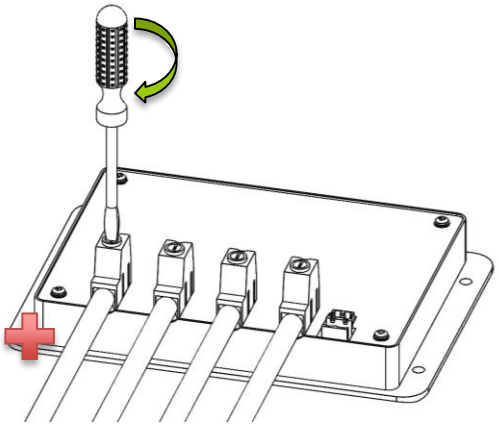


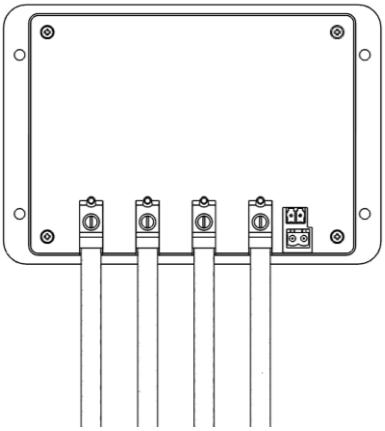


2. Unscrew PV terminals and connect PV connections

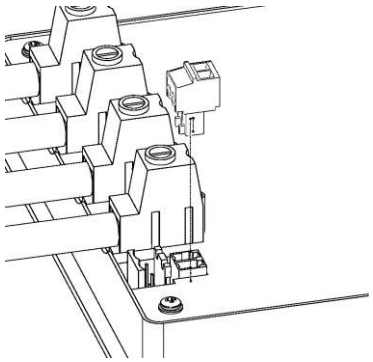


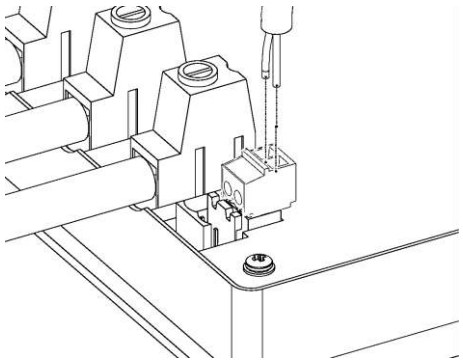


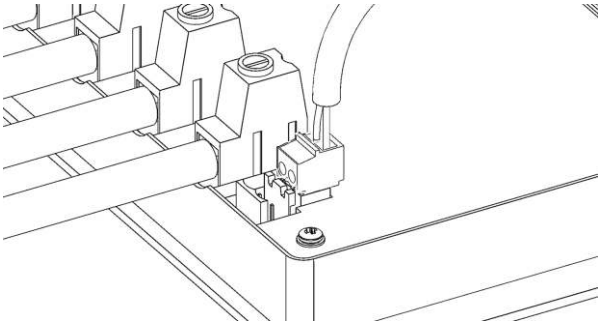




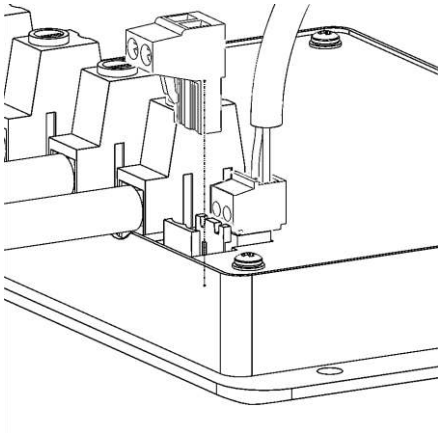
3. Insert temperature sensor block terminal and connect wires (POLARITY SENSITIVITY DOES NOT MATTER)

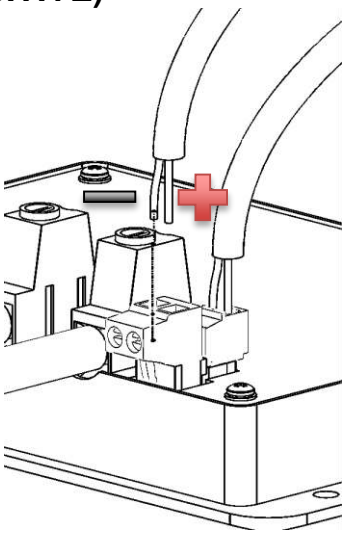


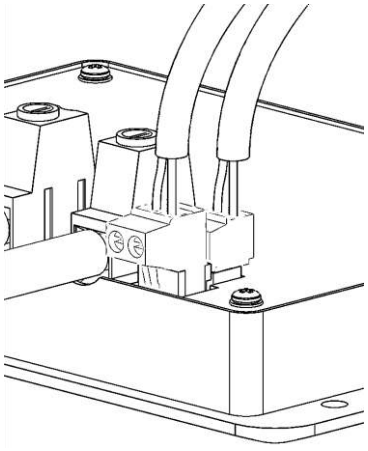




4. Insert battery remote sensor block terminal and connect wires (POLARITY SENSITIVE)



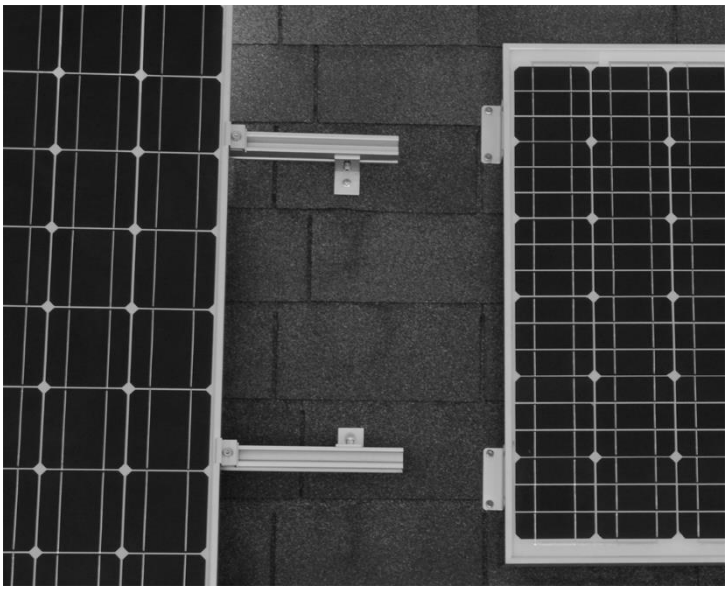




Mounting Systems

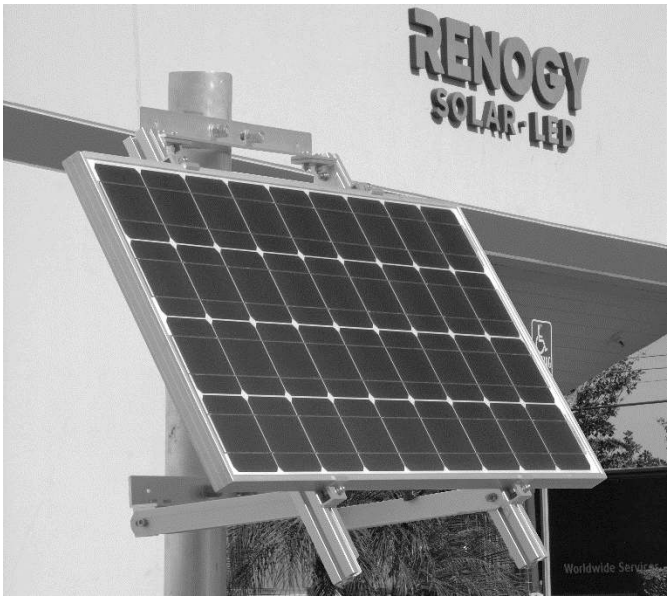
In this section we are going to cover the basics for mounting 12V solar panels using the following:

- **RENOGY** Z-Bracket Mount system
- **RENOGY** Rail Mount System



Rail mount vs. Z-Bracket

- **RENOGY** Single Pole Mount System



Pole mount system with RNG-100

Z-Bracket Mounting



RENOGY Z-Bracket Mounting

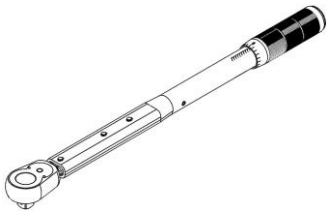
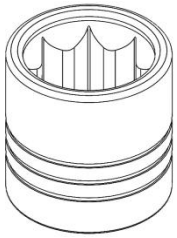
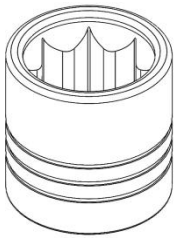
The Renogy Z-Bracket Mount System is designed to support the installation of single panel units, generally in off-grid installations. These units are ideal for installation on RV roofs and non-inhabited dwellings such as sheds or garages. It is also suited as attachment to a user made structure such as a wooden frame. The system comes complete with all fasteners to secure the system to the installation surface. This system makes the installation of small solar systems easy, affordable and quick.

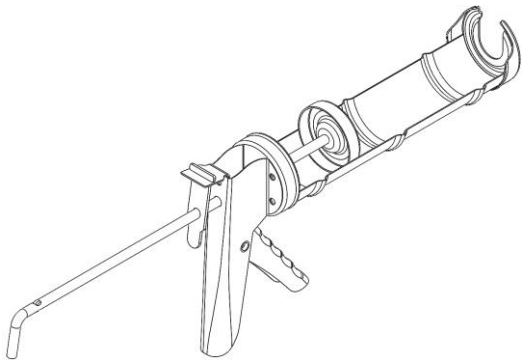
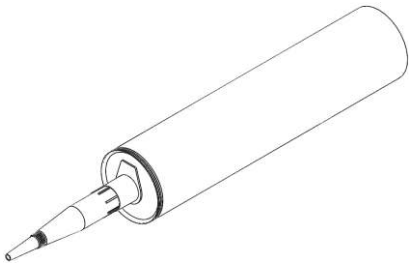
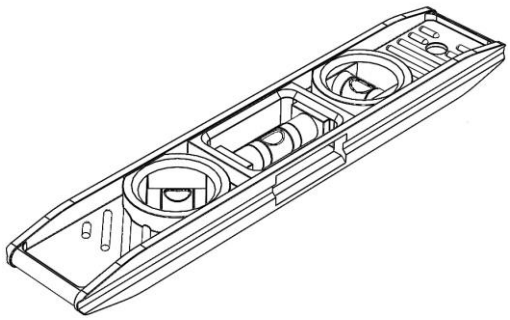
Key Features

- Lightweight
- Aluminum corrosion-free construction
- Ideal for RV's and boats
- Ease of installation
- 1-year material warranty

Recommended tools to have before installation:

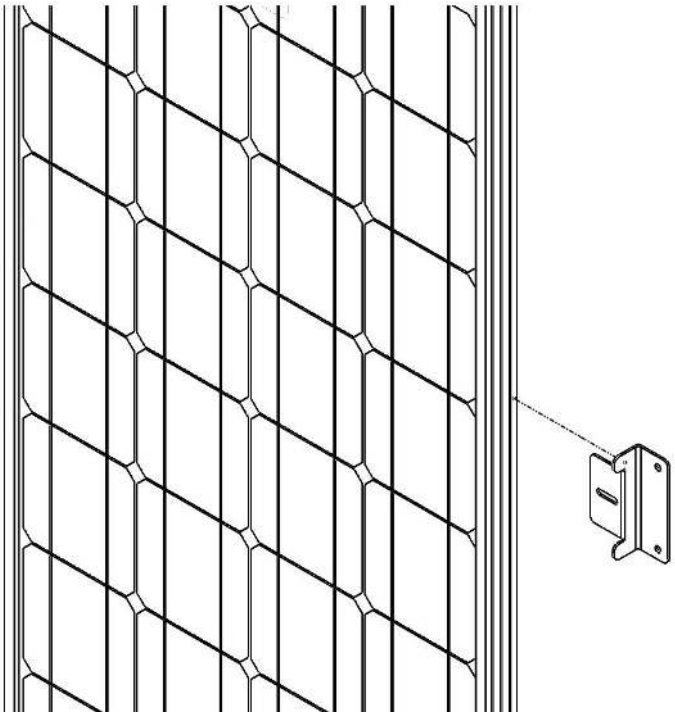
The following tools and equipment are highly recommended to have available to assist with installation but are in no way a comprehensive list of tools that can ease installation. Installers feel free to substitute comparable equipment where appropriate.

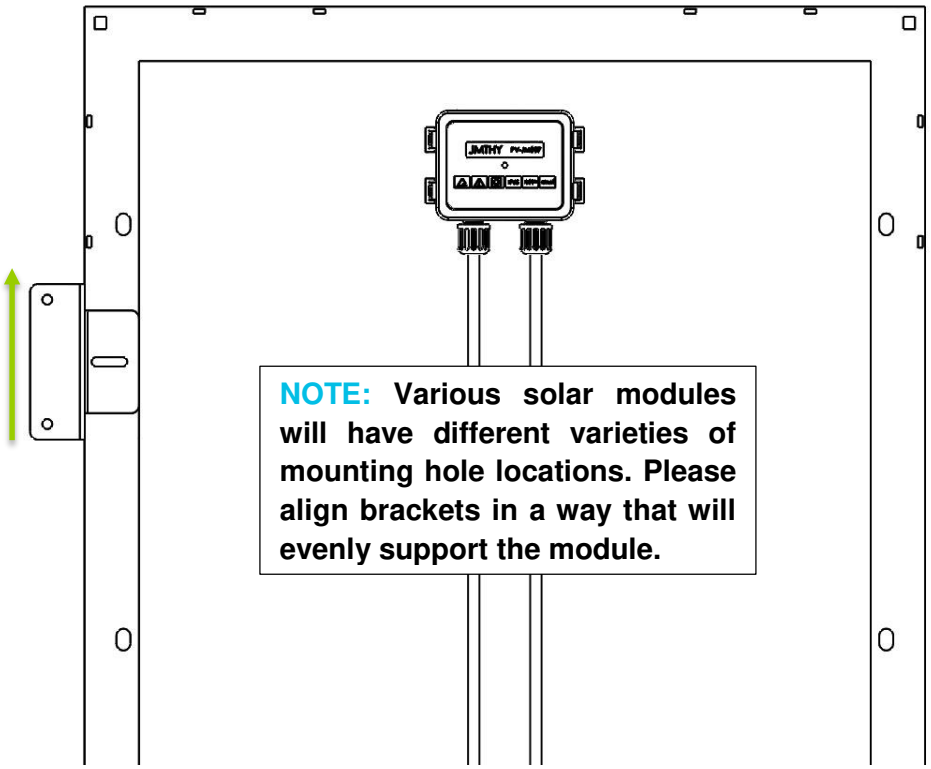
Image	Component	Description
	**Ratchet/Torque Wrench**	Allows for tightening of fasteners. Torque wrench allows for careful monitoring of torque value to prevent overtightening.
	**6mm Socket Drive**	Used with ratchet to tighten down bolted joint between panel and Z-Bracket.
	**5/32” Socket Drive**	Used with ratchet to drive screw into mounting surface and secure Z-bracket to it.
	**Center Punch**	Indents mounting surface to reduce screw wandering during initial drive.
	**Crescent Wrench**	Used to prevent rotation of the nut during joint tightening until split lock washer has effectively engaged.
	Tape Measure	

		May be useful in planning Z-Bracket configuration and positioning.
	**Caulking Gun**	Used to direct sealant into penetrations to avoid leaking.
	**Compatible Sealant**	Sealant compatible with your specific installation.
	**Spirit Level**	Used to ensure panel is level and/or plumb to the mounting surface and orientation.

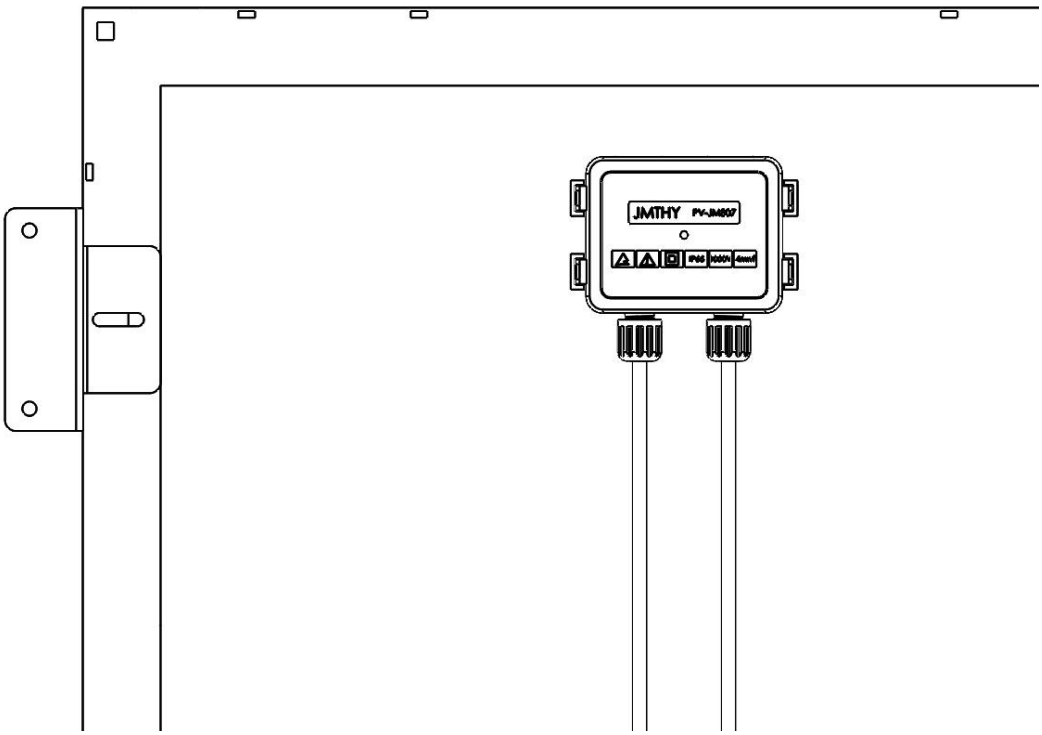
⚠ **WARNING: Installation on shingle roofs is not recommended. System is not designed with these roof types in mind. Fasteners will not penetrate framing deep enough and will likely cause heavy issues with leaking.**

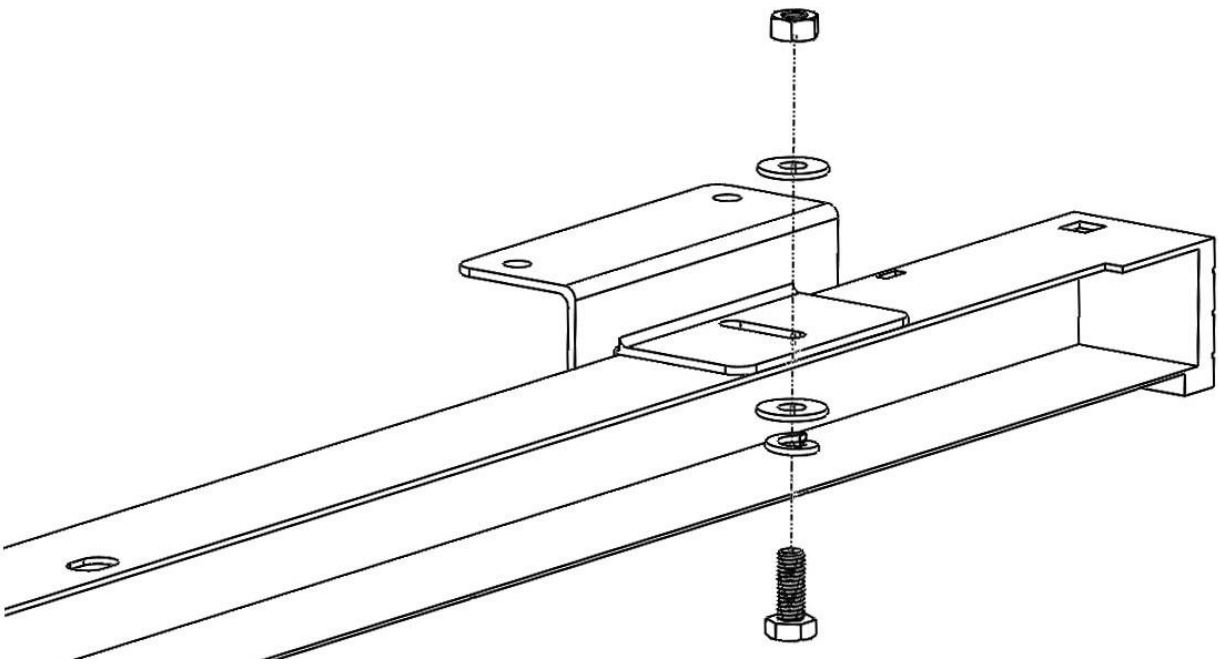
[Making Brackets to panel Frame]

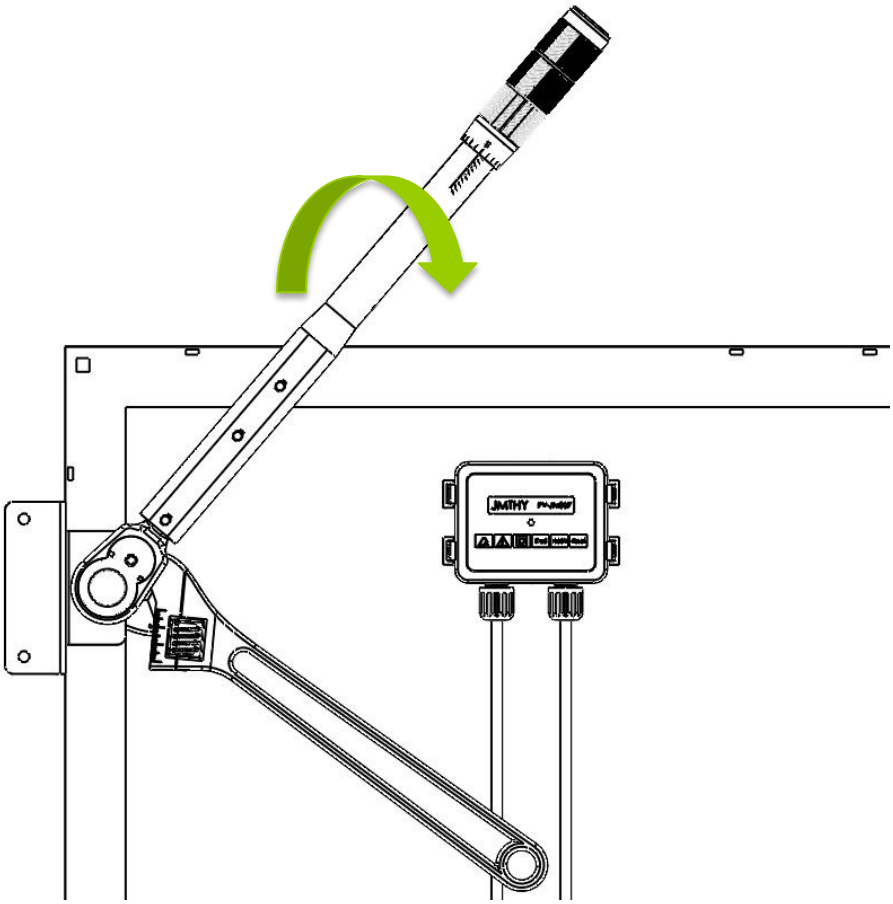


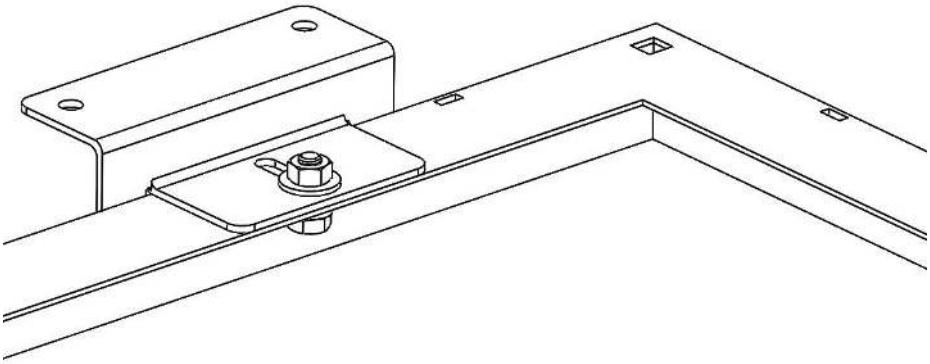


NOTE: Various solar modules will have different varieties of mounting hole locations. Please align brackets in a way that will evenly support the module.


JMTHY

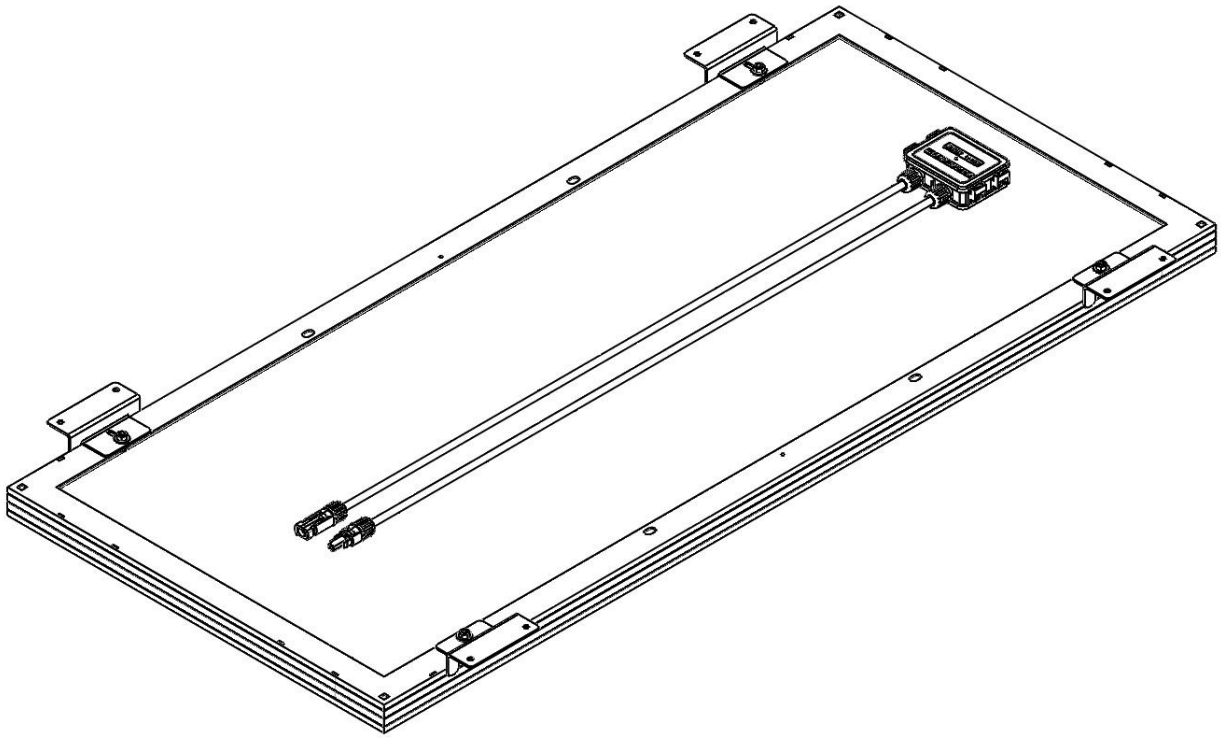




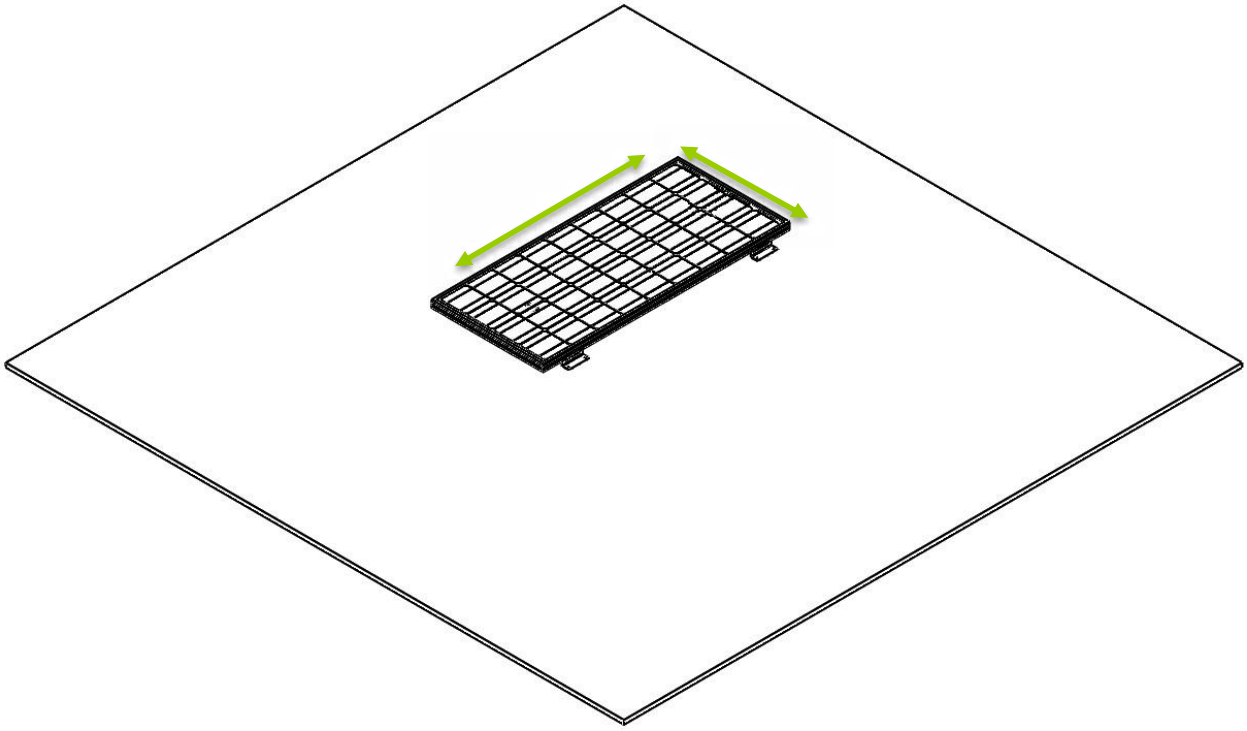


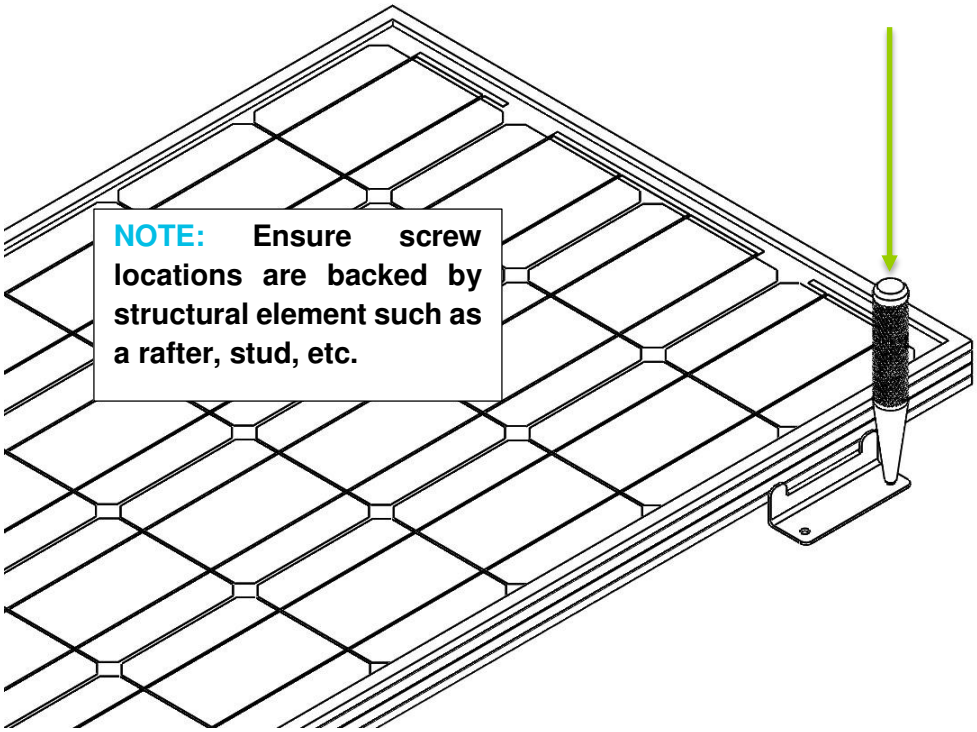


Repeat for each Z-Bracket in the set at each corner.

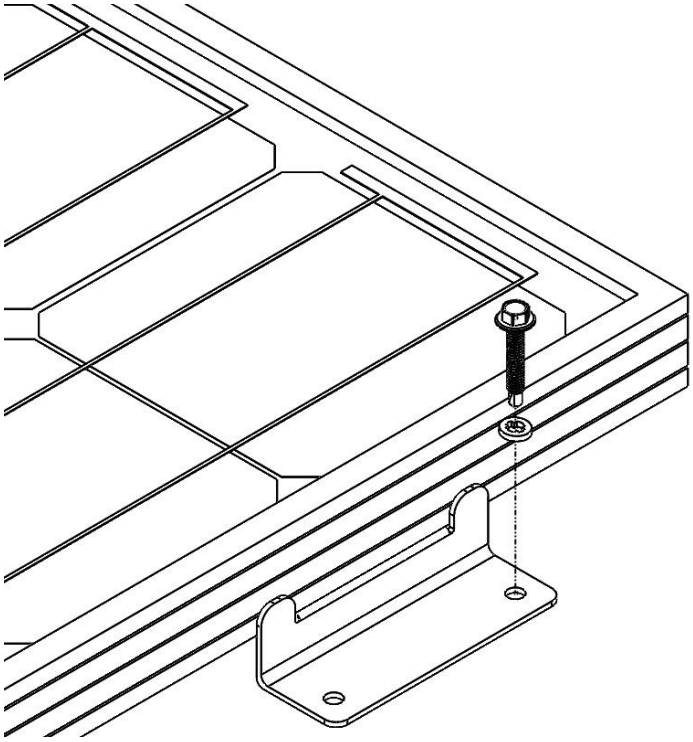


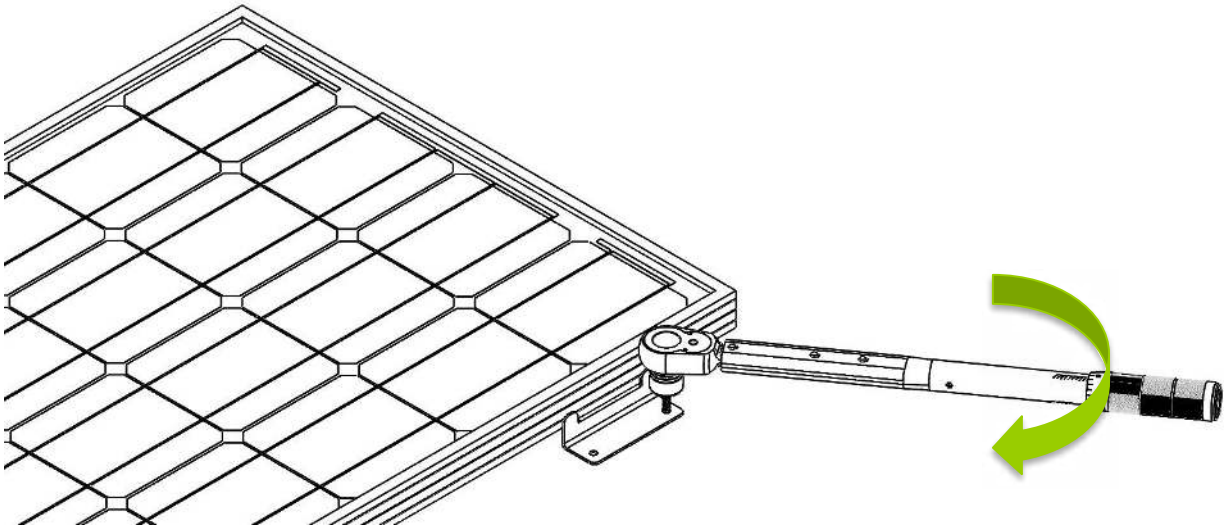
Install of Panel to General Mounting Surface

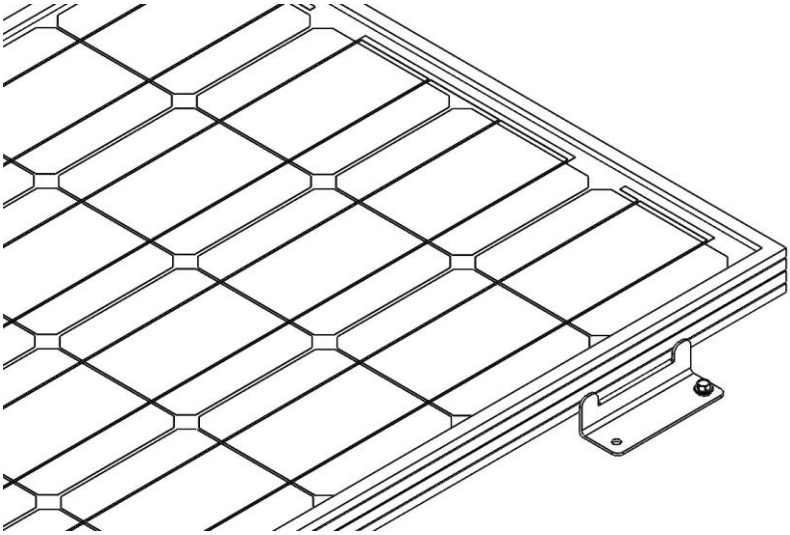


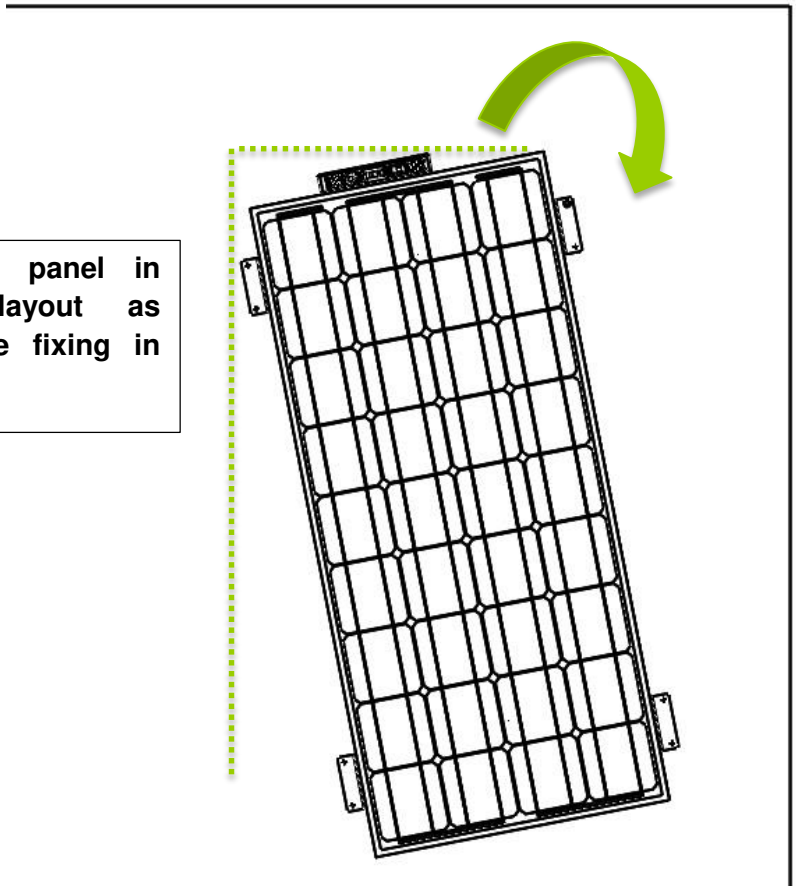


NOTE: **Ensure screw locations are backed by structural element such as a rafter, stud, etc.**

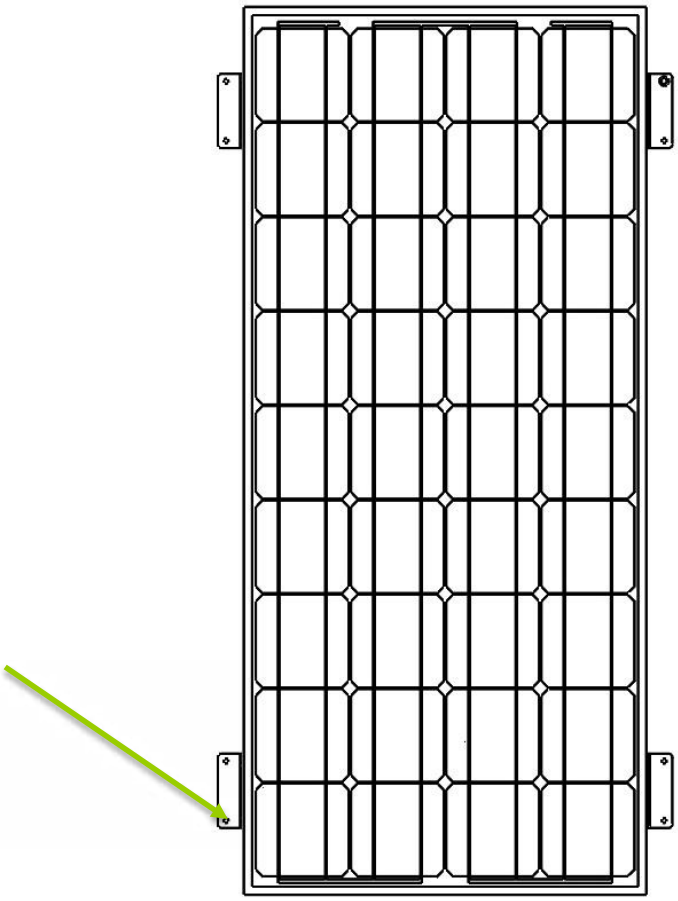






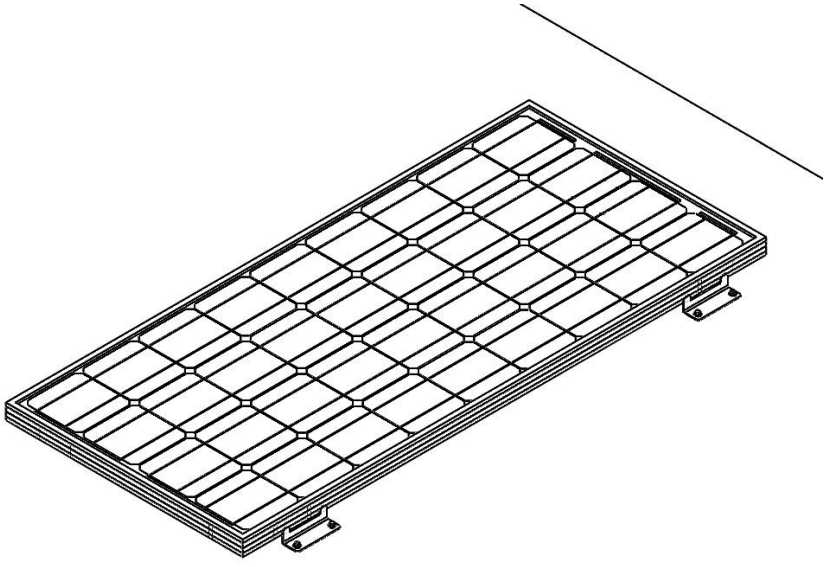


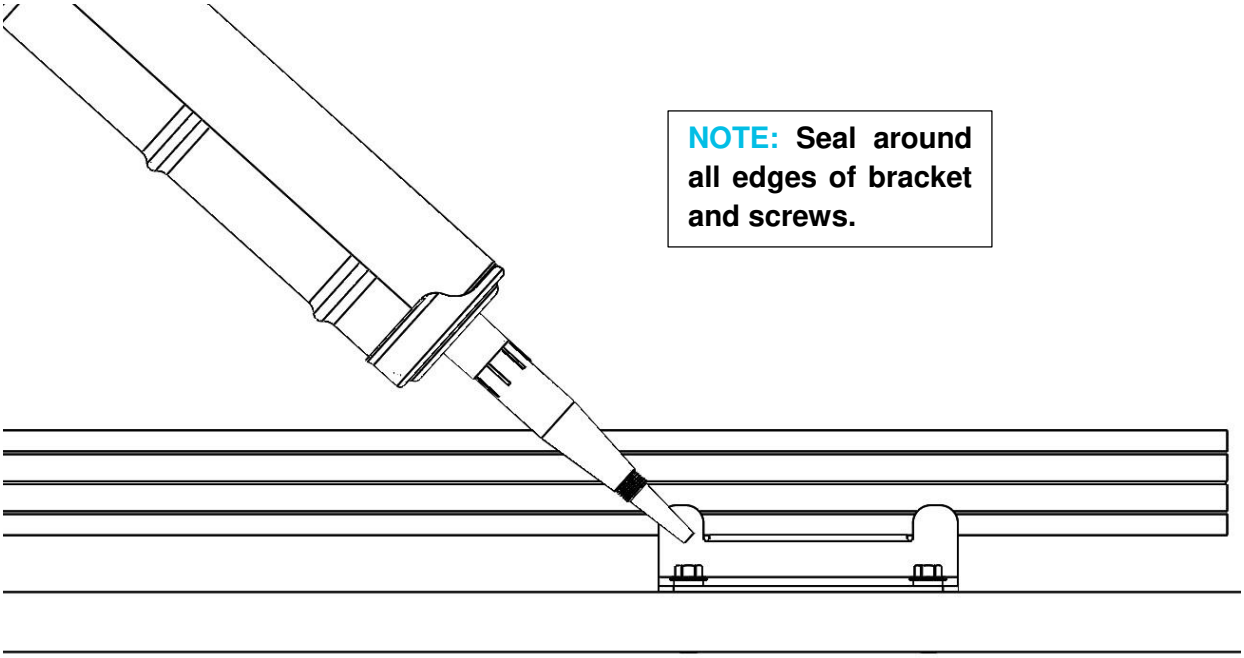
NOTE: Orient panel in level/plumb layout as desired before fixing in position.



NOTE: Begin new fastener at indicated location first to secure panel in level plumb/level layout.

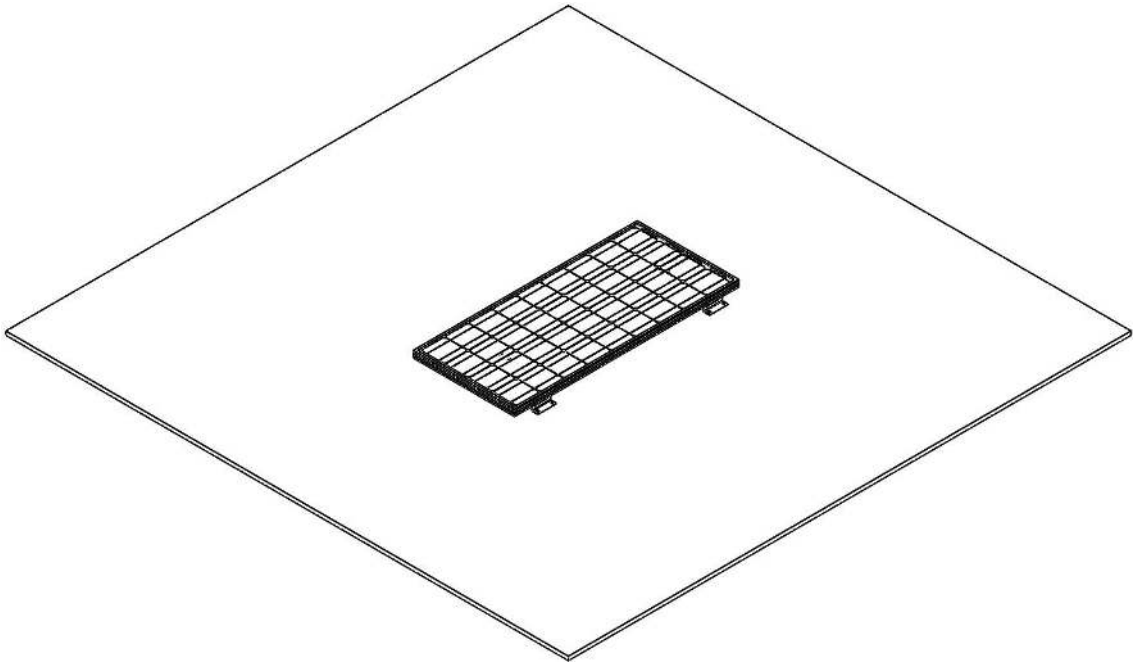
Repeat for all fastener locations.





NOTE: Seal around all edges of bracket and screws.

Repeat for all brackets.

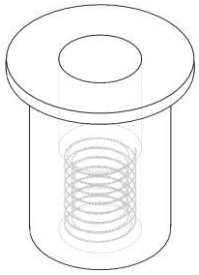
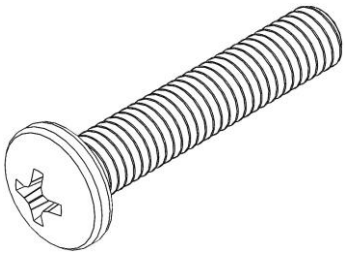
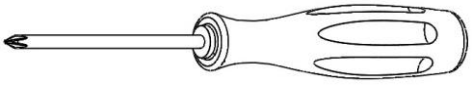


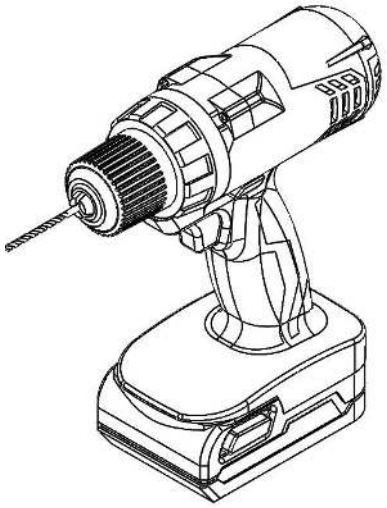
Install of Panel to RV Roofs

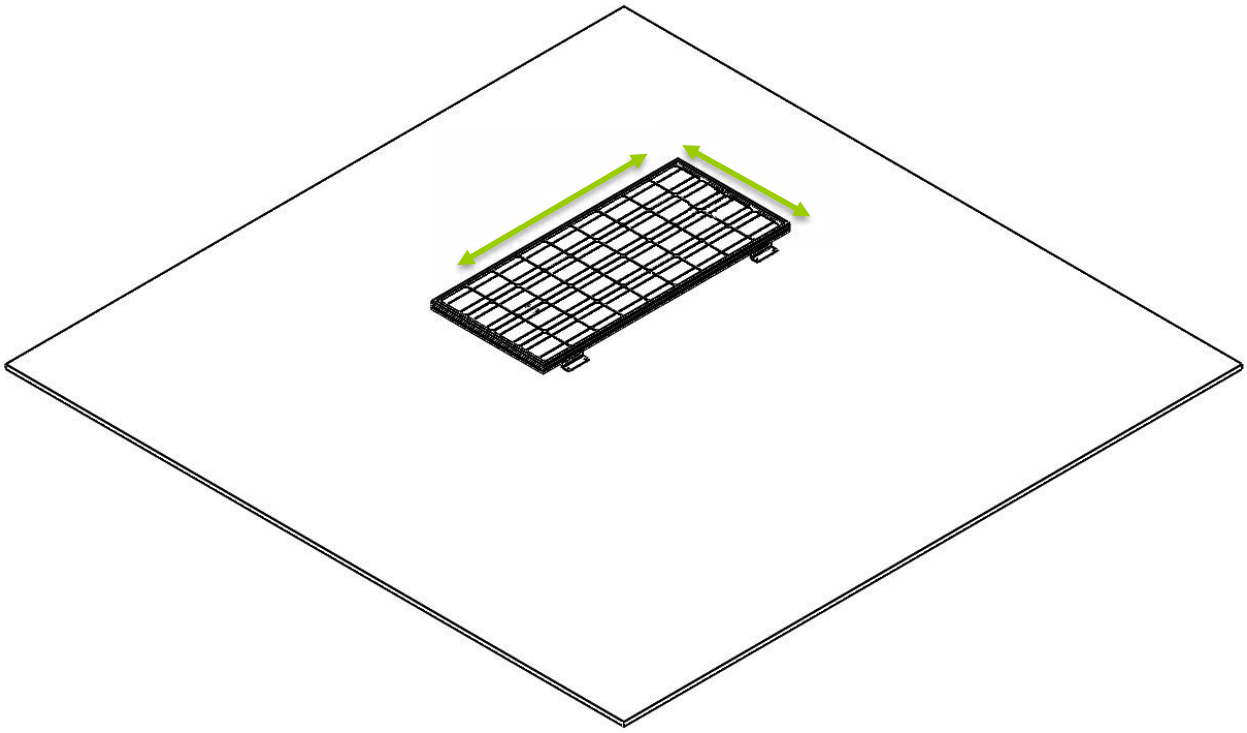
Installation on to the roofs of RV's typically requires more specialized instruction due to the nature of construction of most commercially available RV roofs. Please note that this section includes the use of a fastener type **NOT** included in the Z-Bracket kit. This section is included for convenience of customers installing to an RV roof. The instructions listed in this section are a modification of the normal installation, all other steps are to be completed normally.

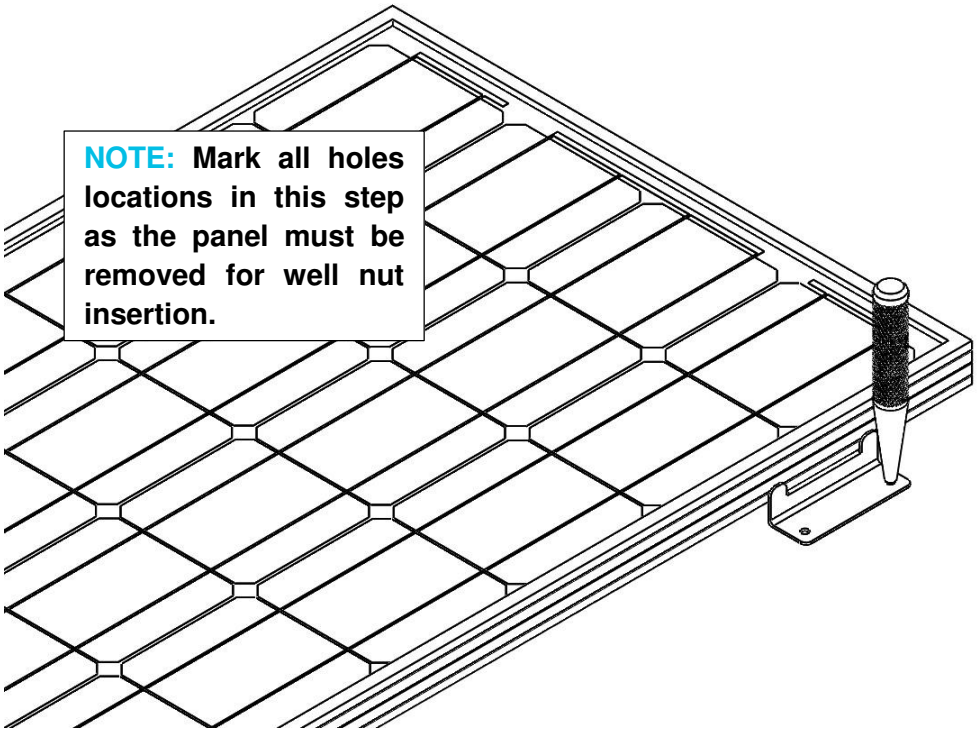
NOTE: A minimum roof thickness of 3/8" is recommended for this type of installation.

Additional components and tools required for this section:

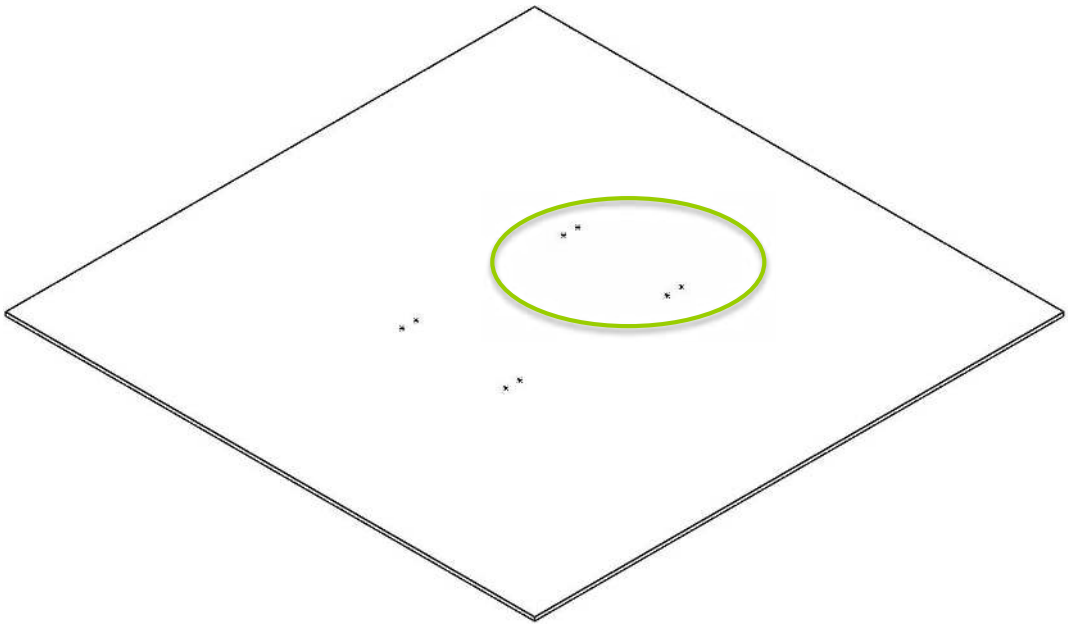
Image	Component	Description
	**Well Nut**	Special recessed fastener which expands as the internal fastener is tightened. Allows for fastener to seal within mounting surface and embed itself tightly. Need variety with at least #10-32 internal thread, material thickness supporting roof thickness, and 3/8" hole size. A fastener with suggested features can be found here: http://www.mcmaster.com/#93495a190/=xfp203 http://www.homedepot.com/p/Everbilt-10-32-tpi-x-5-8-in-Brass-Expansion-Nut-814358/204276054
	**Machine Screw**	Used to secure Z-Brackets to surface with well nut. Must be compatible with chosen well nut by having the same internal thread and not longer than the length of the well nut. Must also purchase compatible flat and lock washers.
	**Phillips Head Screw Driver**	Used to secure machine screw into well nut.

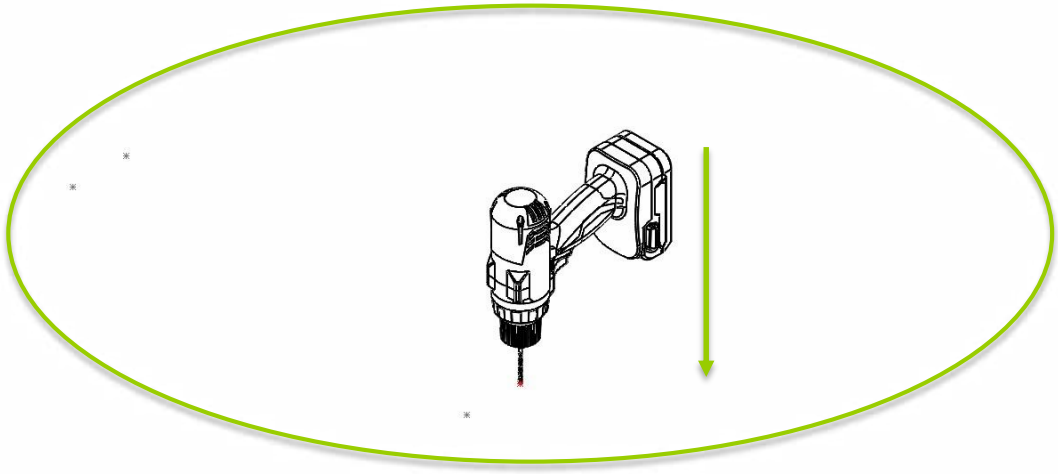
	**Cordless Drill**	Used to drill clearance holes for well nuts in roof top.
	**Drill Bit**	Used with Cordless Drill to create clearance holes for the well nuts. Must be matched to the well nut's outer diameter. Recommended variety requires 3/8" bit.

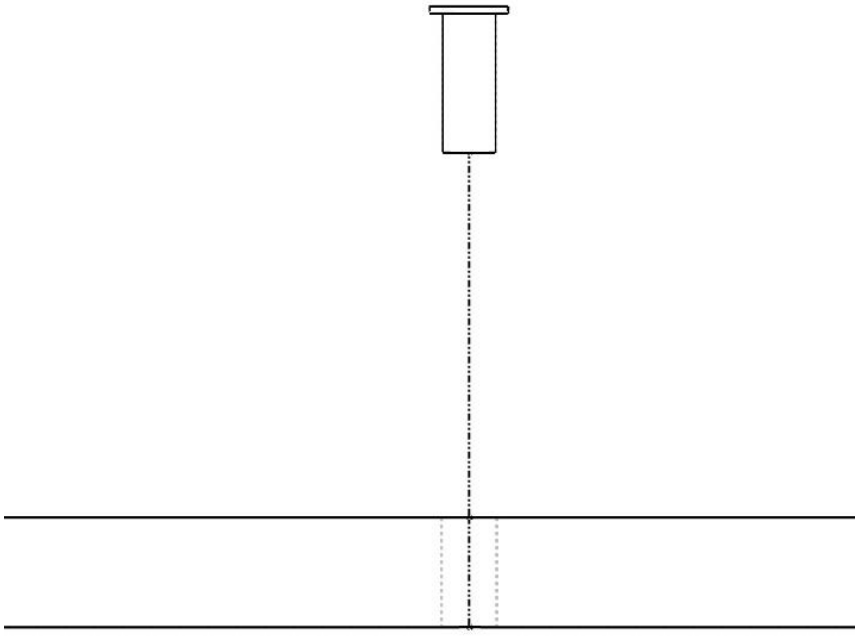


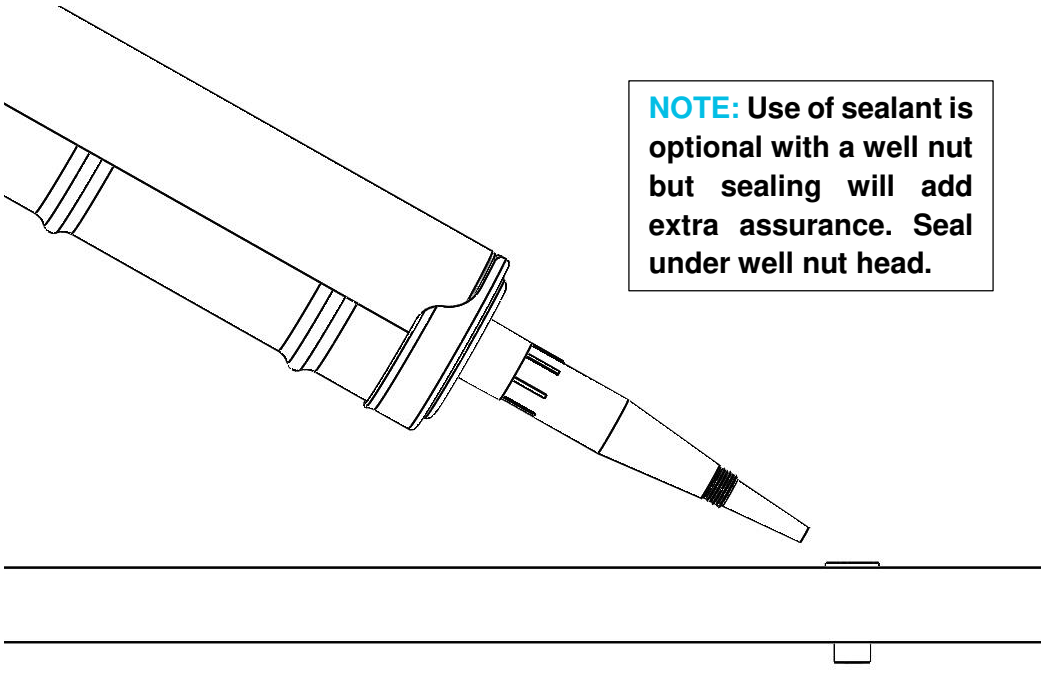


NOTE: **Mark all holes locations in this step as the panel must be removed for well nut insertion.**



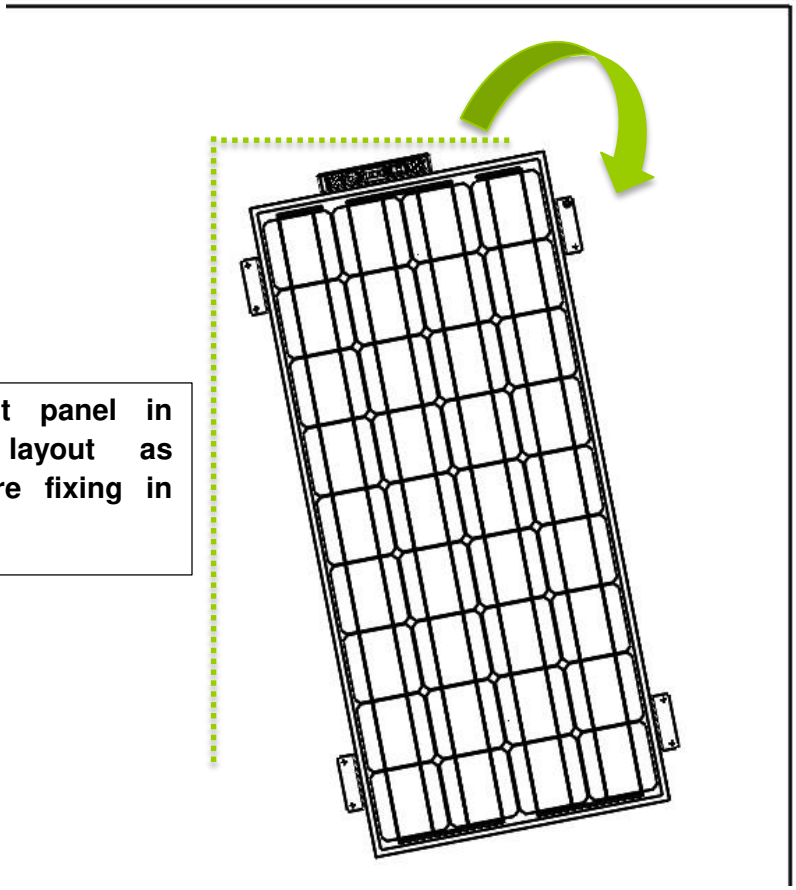




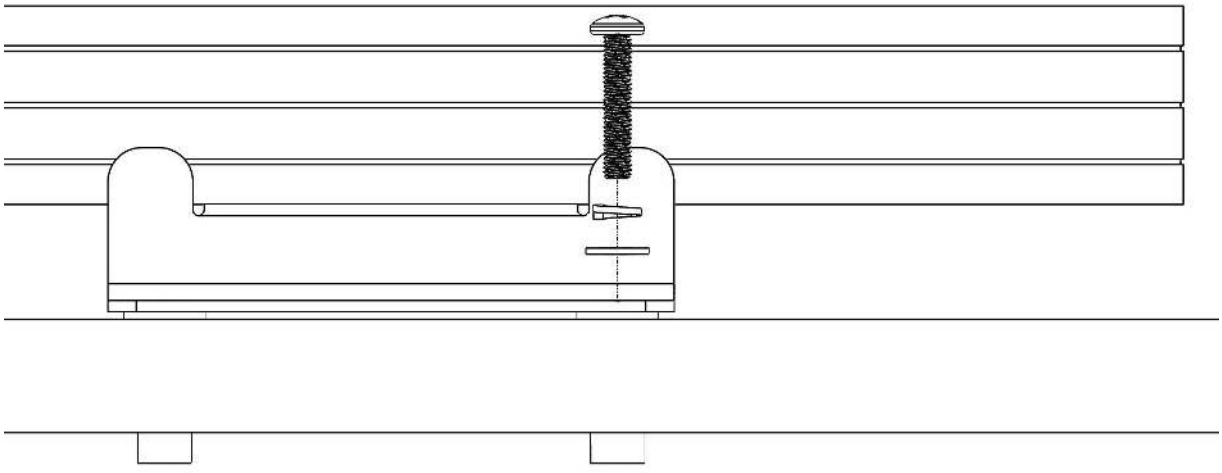


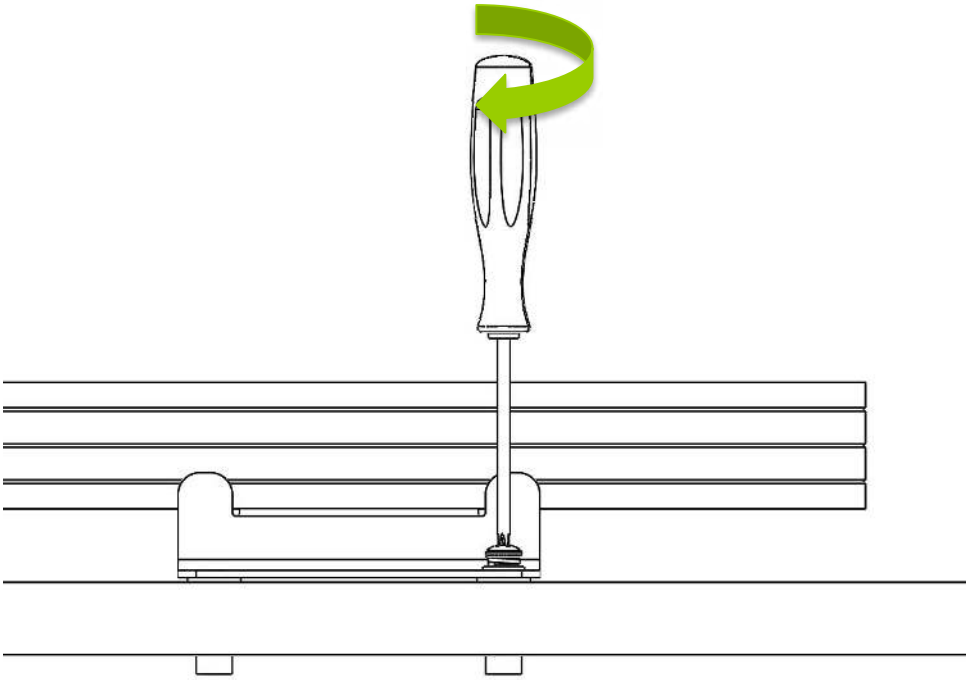
NOTE: Use of sealant is optional with a well nut but sealing will add extra assurance. Seal under well nut head.

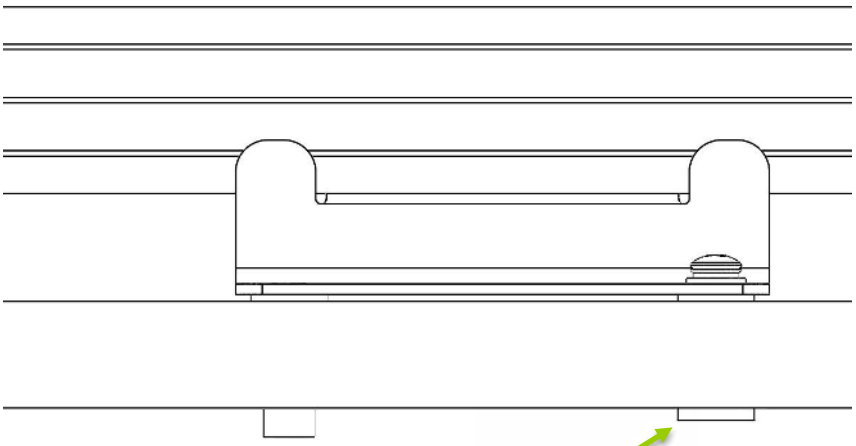
Repeat for all holes.



NOTE: Orient panel in level/plumb layout as desired before fixing in position.







NOTE: Screw has compressed and expanded the well nut, binding into the roof material.

Repeat for all fasteners.

RENOGY Rail Mount System

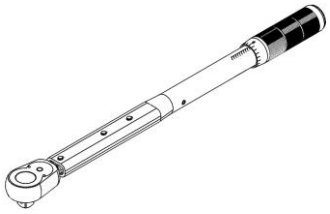
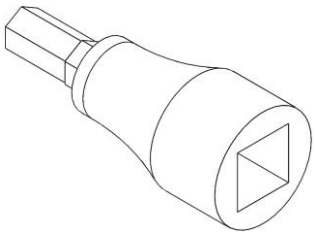
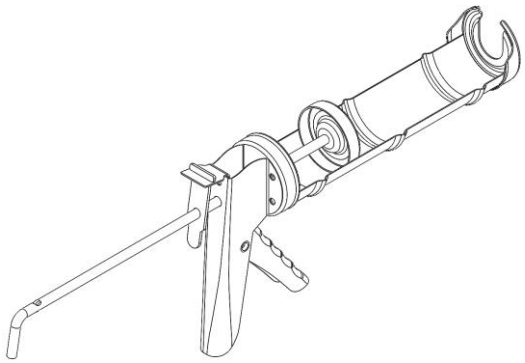
The Renogy Rail Mount System is designed to support off-grid and grid-tied solar photovoltaic systems and is compatible with all Renogy panel sizes, 100 W and larger. The system contains multiple components which will vary depending on a particular installation's needs. A typical system will be comprised on the rail units themselves coupled with Splice Kits, L-Feet, End Clamps, and Mid Clamps as well as all required fasteners to secure all components together. This product makes the installation of long continuous rows of panels easy. This system is designed for use on flat rigid surfaces to ensure system stability.

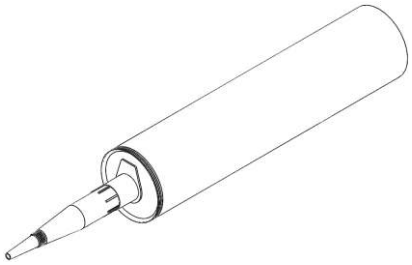
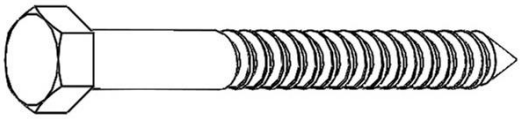
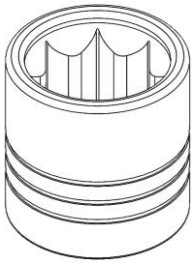
Key Features

- Lightweight
- Supports multiple panel thicknesses
- Anodized Aluminum 6063-T5 Corrosion-Free Design
- Attractive mill finish, surface roughness B, C
- Snow loads up to 1.4 KN/m^2 (0.20 psi)
- Wind speeds up to 60 m/s (134 mph)
- 1-year material warranty

Recommended tools to have before installation:

The following tools and equipment are highly recommended to have available to assist with installation but are in no way a comprehensive list of tools that can ease installation. Installers feel free to substitute comparable equipment where appropriate.

Image	Component	Description
	**Torque Wrench**	Allows for tightening of fasteners to a specified maximum torque. Prevents overtightening and better control of joint assembly.
	**6mm Hex Bit w/ Socket Drive**	Bit to be used with torque wrench to drive hex cap bolts within the system assembly. Ensure drive side is sized appropriately to your particular socket wrench key (usually 3/8”).
	**Tape Measure**	Used to accurately mark spacing of pilot holes which locate the roof attachments for the L-Feet.
	**Caulking Gun**	Used to direct sealant into penetrations to avoid leaking in the roof.

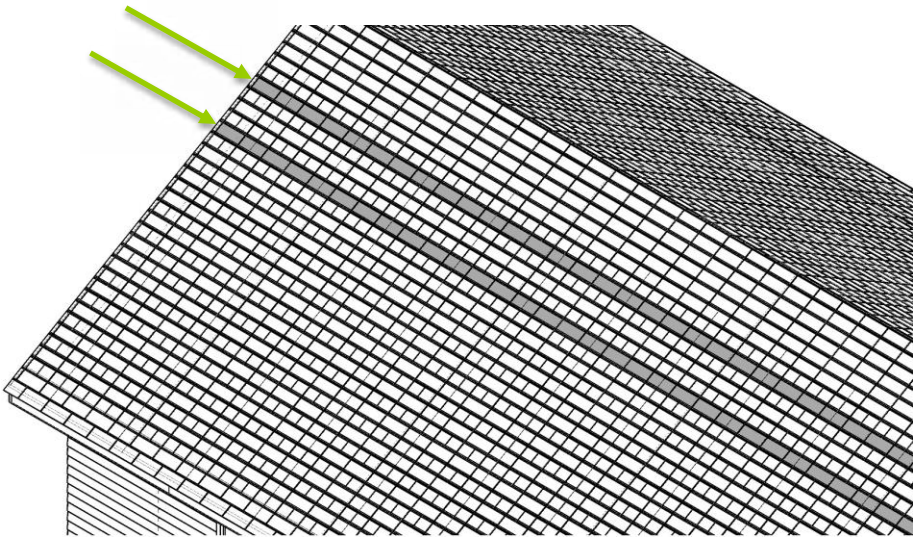
	**Compatible Sealant**	Sealant compatible with your specific roof installation. Consult with documentation/warranty paperwork for the roof.
	**7/32” Drill Bit**	Used to drill pilot holes for the roof attachment bolts. Recommended 3” in length.
	**5/16” Lag Bolt**	Fastener to be torqued down into roof studs. Secures L-Feet to roof. Recommended 3” in length. Needs compatible zinc-coated washer.
	**½” Socket Drive**	Used in conjunction with the torque wrench to tighten down lag bolts into the roof structure.

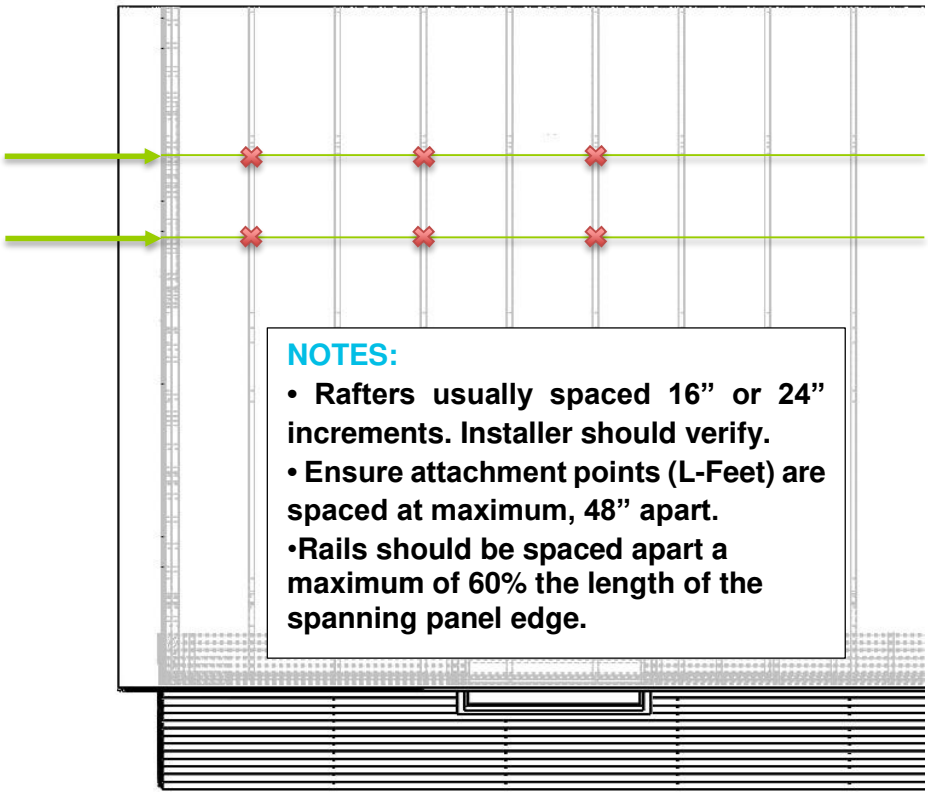
⚠ **WARNING: Installation of this system poses serious injury risks due to work on roofs. NEVER work alone during the installation of the system and ALWAYS use fall protection equipment. NEVER use any of the equipment attachment points as a support for fall protection.**

Roof Securements for Attachment Points

CAUTION: **If using an alternative base for the L-Foot such as the MTS-QMSC or a third party stand-off system to clear obstructions, please consult those product manuals for additional instruction before proceeding with this section.**

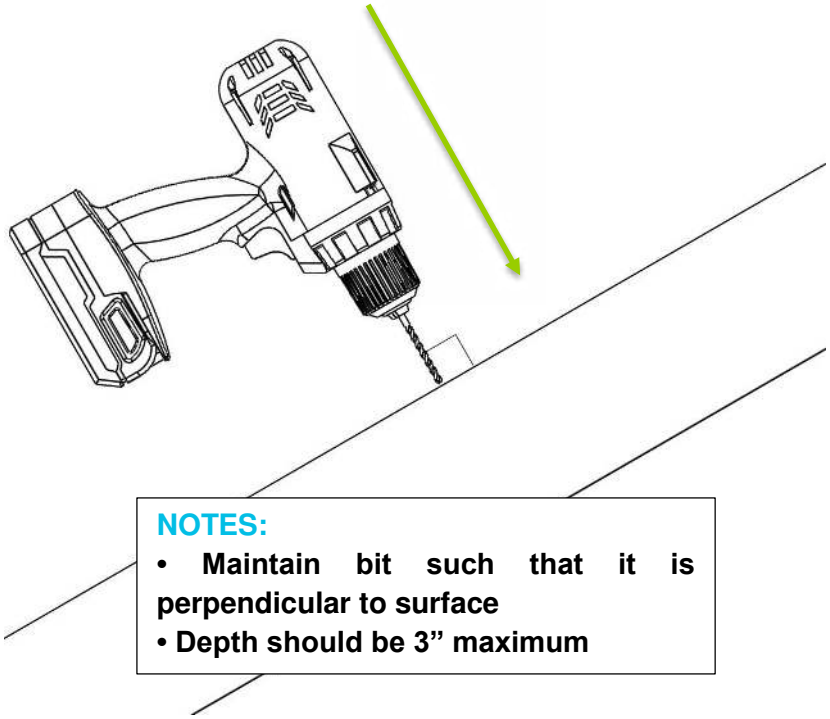
NOTE: **Leave L-Foot fasteners attached to the unit as they come packaged. This will ease attachment to the railing components later in the installation.**





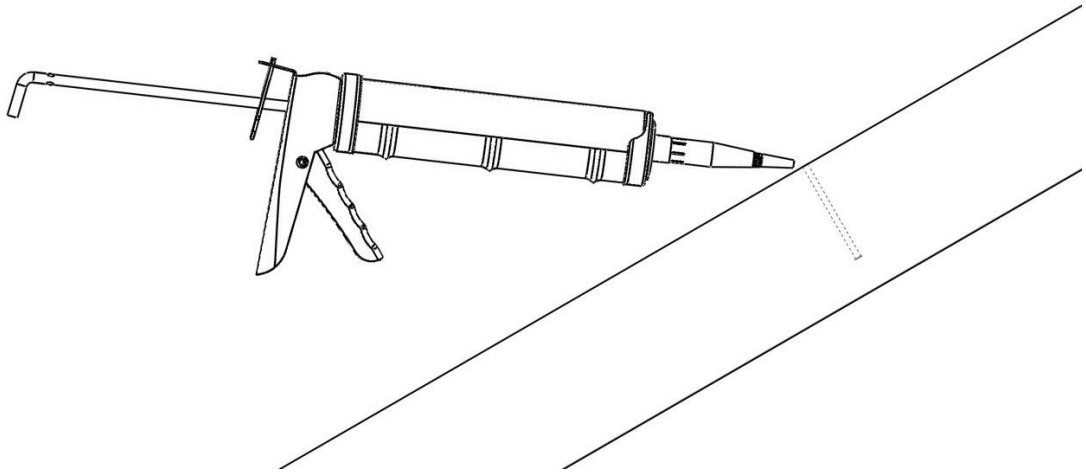
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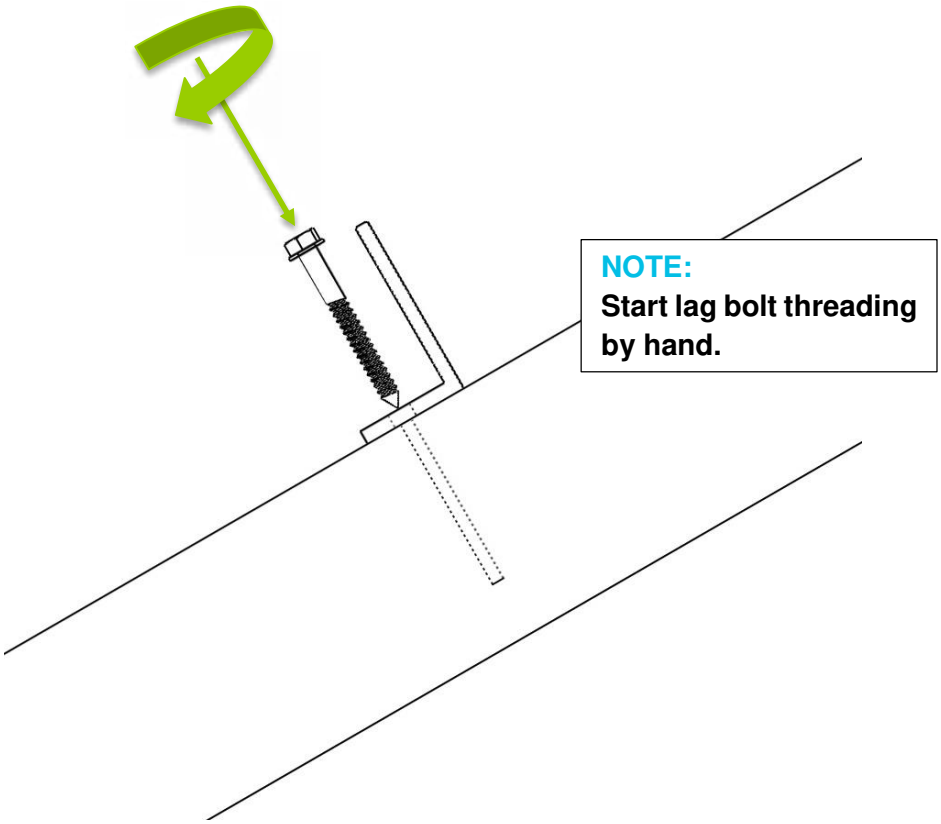
- **Rafters usually spaced 16” or 24” increments. Installer should verify.**
- **Ensure attachment points (L-Feet) are spaced at maximum, 48” apart.**
- **Rails should be spaced apart a maximum of 60% the length of the spanning panel edge.**



NOTES:

- **Maintain bit such that it is perpendicular to surface**
- **Depth should be 3” maximum**

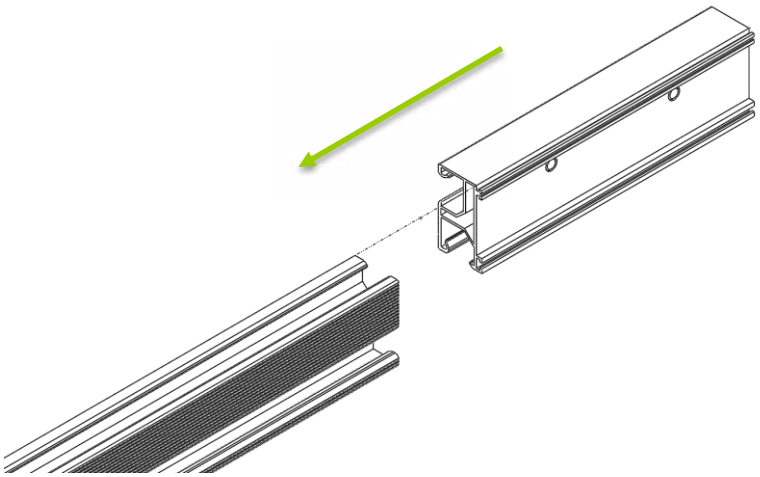




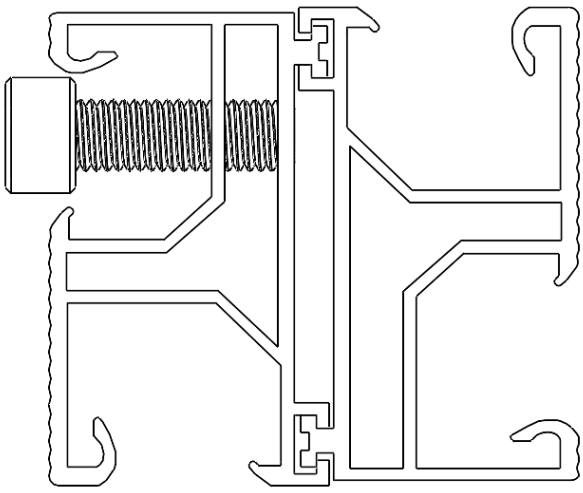
NOTE:
Start lag bolt threading by hand.

Rail System Construction

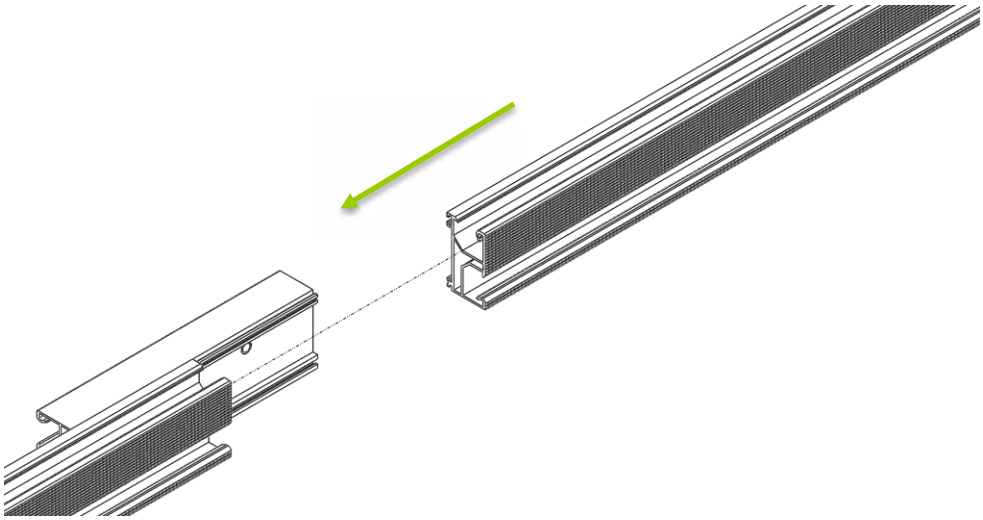
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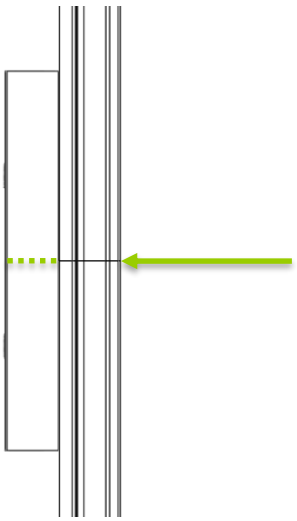
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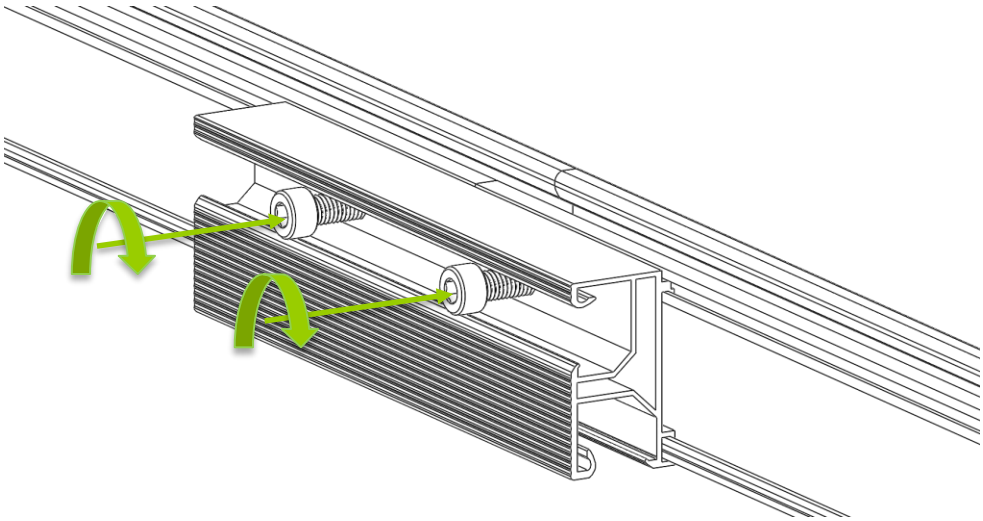
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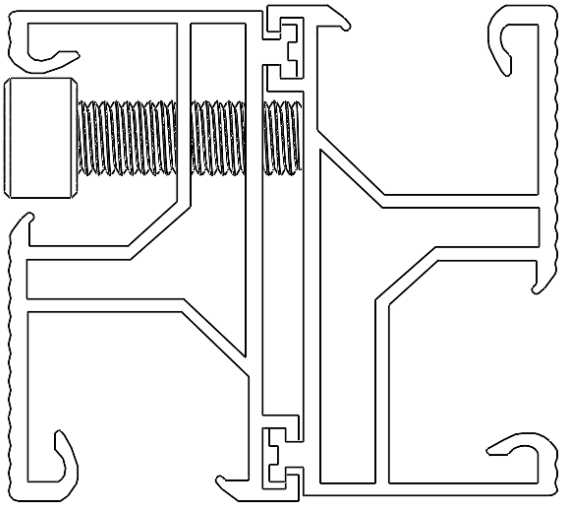
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6



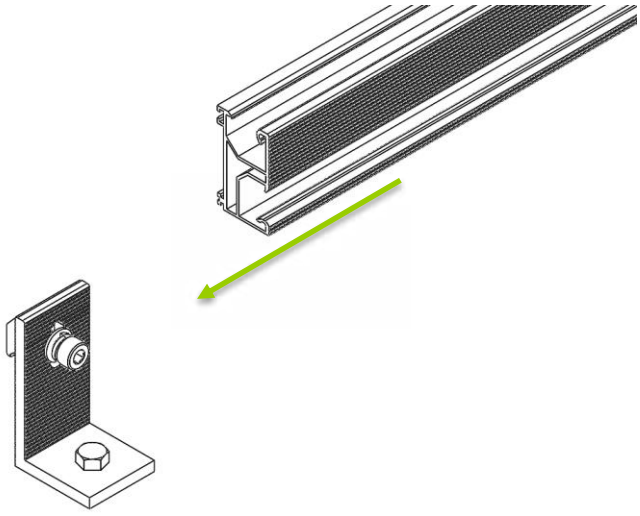
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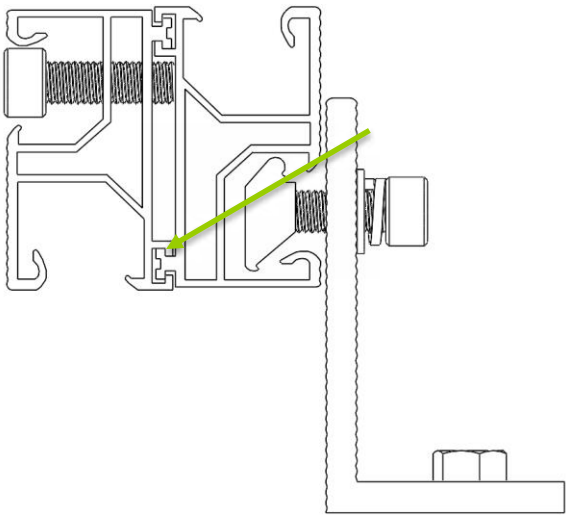
Repeat for all continuous rail sets.

Rail Seating

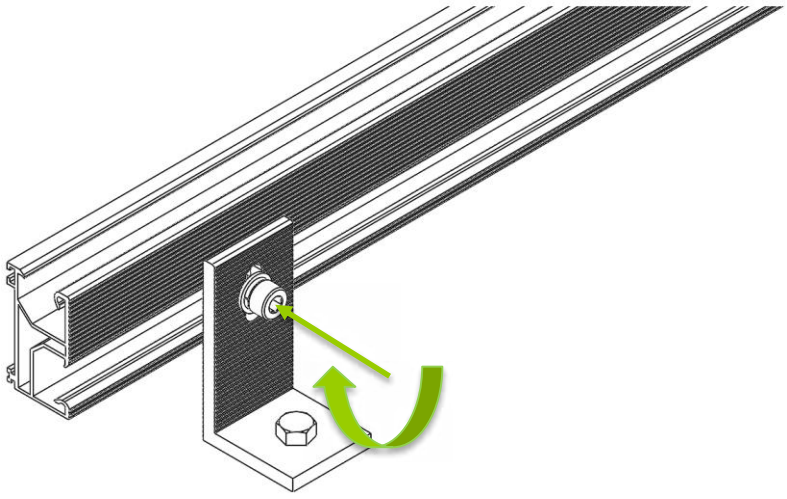
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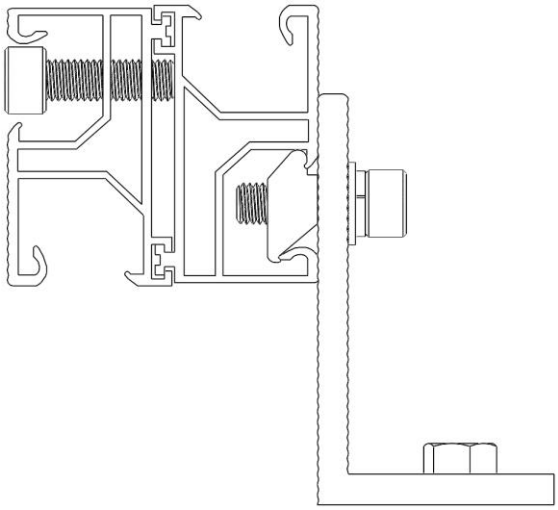
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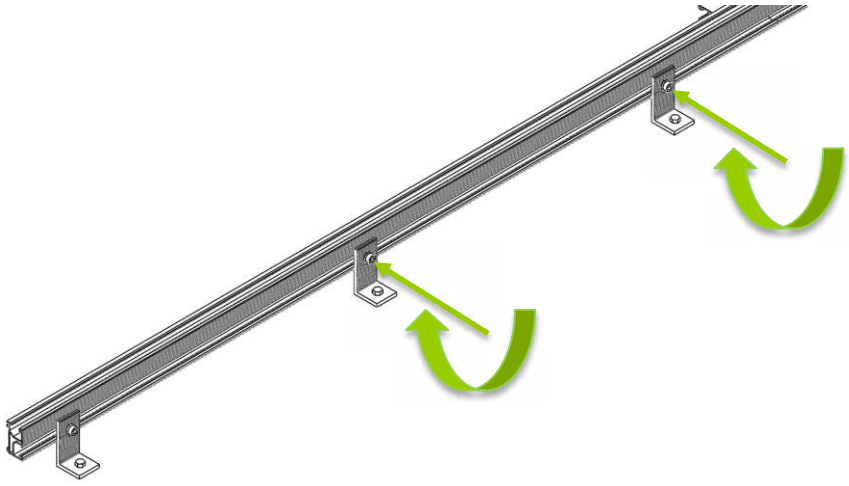
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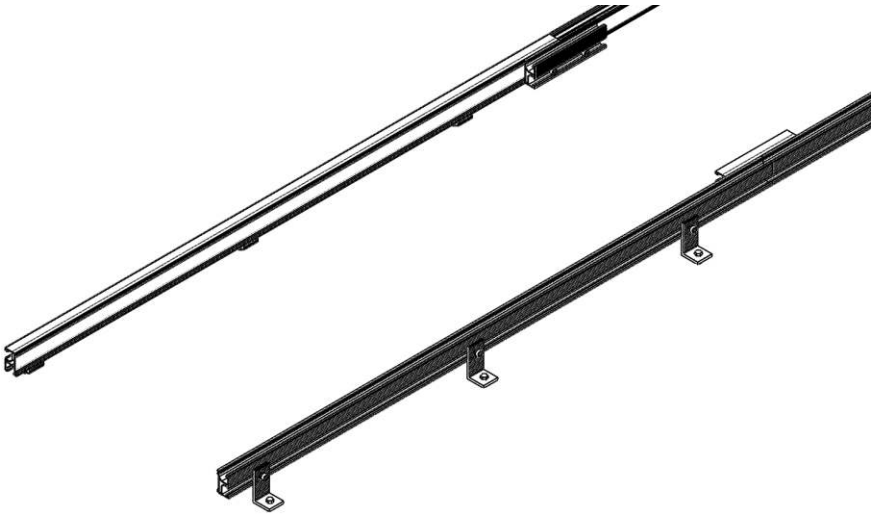
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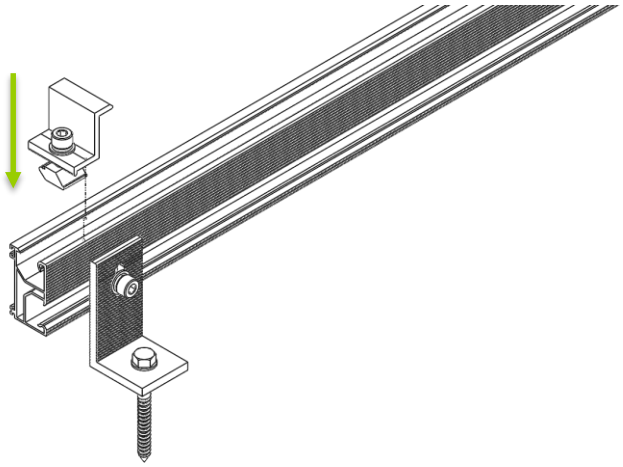


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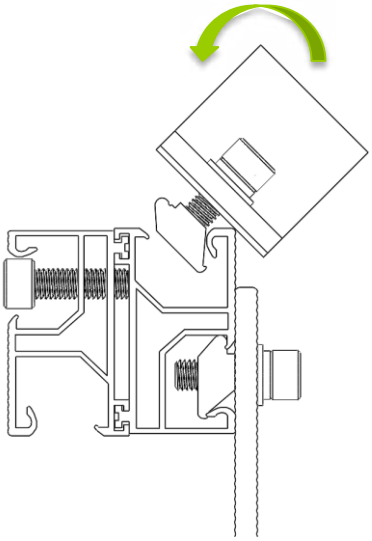
Panel Securement

1

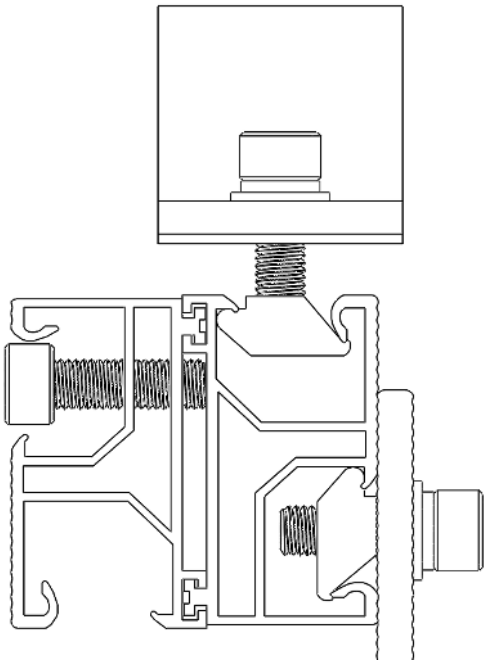


⚠ **WARNING: End clamps must be installed a minimum of 1” (30 mm) from the rail edges.**

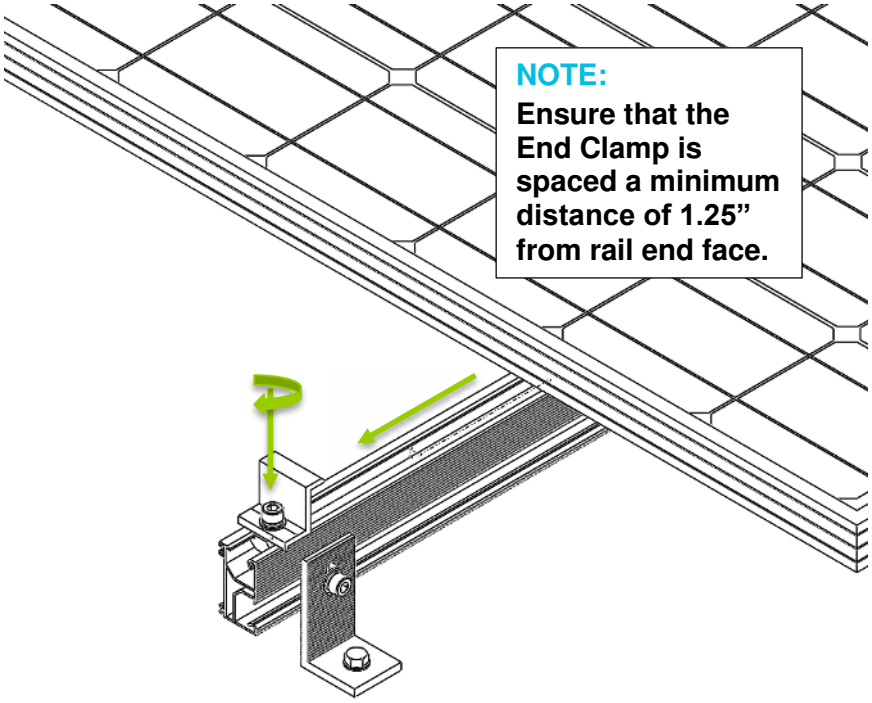
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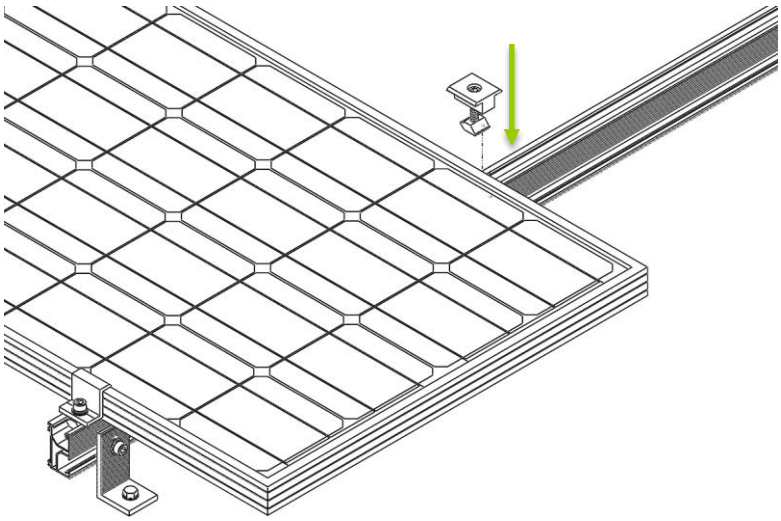
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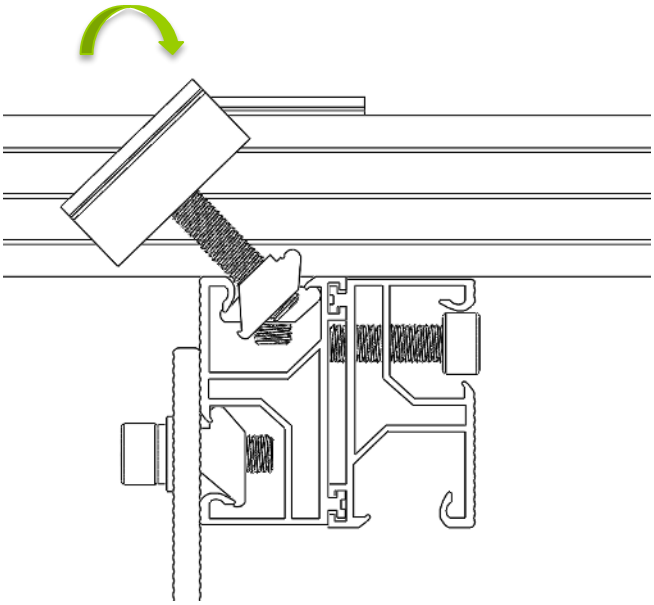
4


NOTE:
Ensure that the End Clamp is spaced a minimum distance of 1.25” from rail end face.

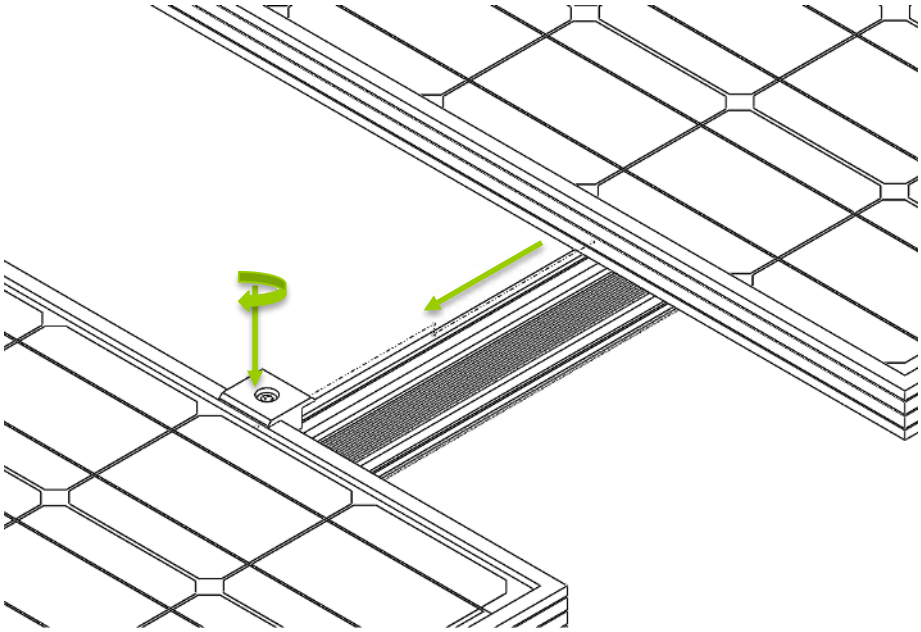
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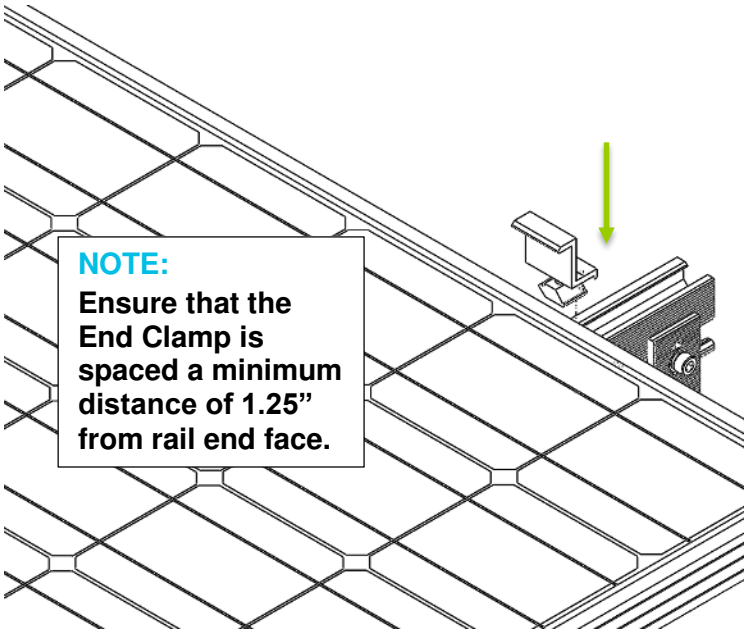


7



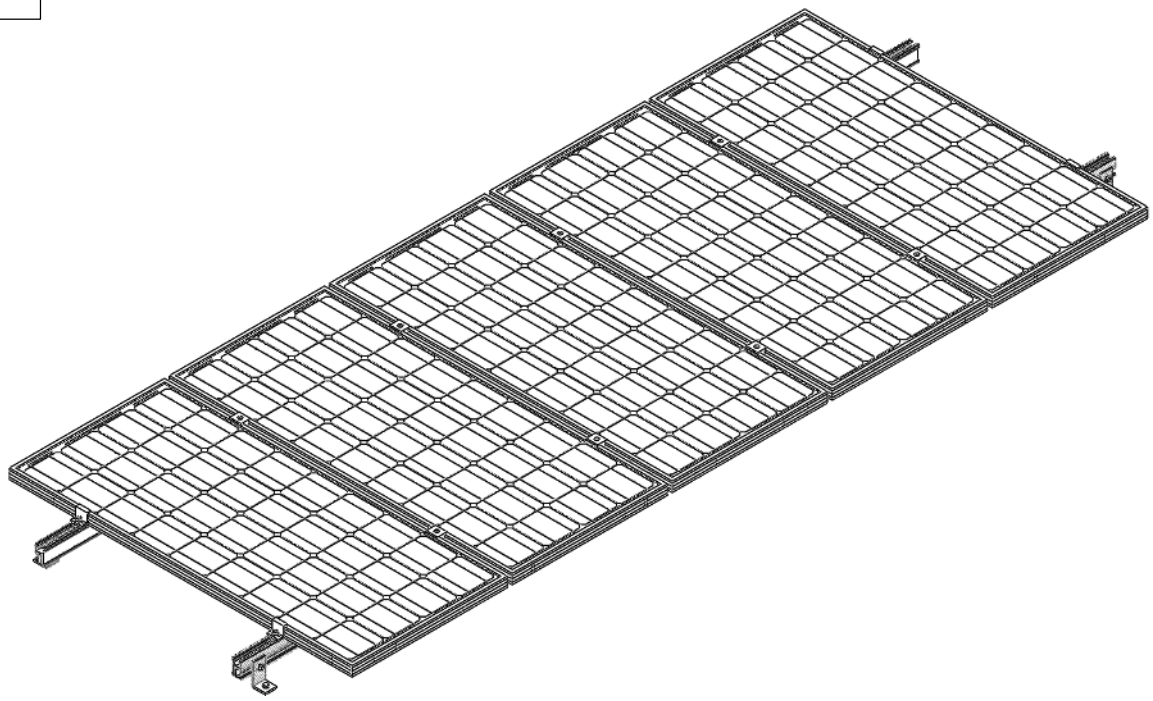
Continue mid-clamp procedure for each additional panel.

8



⚠ **WARNING:** **End clamps must be installed a minimum of 1” (30 mm) from the rail edges.**

9



Repeat procedure for each panel row.

RENOGY Pole Mount System

The Renogy Pole Mount System is designed for off-grid applications, when mounting to a roof is not ideal. It will support off-grid systems, and panels up to 100W. The system comes complete with all fasteners to secure the system to the installation surface. This system makes the installation of small solar systems easy, affordable and quick.

Key Features

- 5052-H32 aluminum construction
- Stainless steel fasteners
- High-tensile strength
- Corrosion Free
- Withstands 50 psf (125 mph wind loads)
- Attractive brushed aluminum finish
- Infinitely adjustable between 15-65 degrees
- Precision hole positioning and alignment
- Easy, rapid assembly
- Well-illustrated instructions
- Wind resistance of 120mph
- 1-year material warranty

Recommended tools to have before installation (Not Provided):

- Socket wrench
- Torque extension
- Box-Leveler
- Tape Measure
- 18mm wrench or socket for larger hex nut
- 13mm wrench or socket for smaller hex nut

The above tools and equipment are highly recommended to have available to assist with installation but are in no way a comprehensive list of tools that can ease installation. Installers feel free to substitute comparable equipment where appropriate.

Note: All Cap Head Bolts (G) must have a Washer (H) and Spring Washer (I) prior feeding through a hole.

Fasten L-Channels to L-Brackets

A. Place Washer (H) flush to top surface of L-Channel (B), and align the holes.
B. Slide the Spring Washers (I)) onto the Cap Head Bolt's (G) thread so that the bottom face of the Cap Head Bolt is touching the top surface of the spring washer.
C. Feed the thread of the Cap Head Bolt (G) through both L-Channel (C) and Washer's hole. Repeat for all 4 holes.
D. Align the L-Bracket (C) with the bottom face of the L-Channel (B) and feed the protruding threads through the L-Bracket holes. Make sure the L-Bracket is flush and tighten bolts.
E. Fasten the L-Bracket (C) to L-Channel (B) with two small Nuts (K).
F. Repeat for both sets of L-Channel (B), fasteners, and L-Bracket (C).

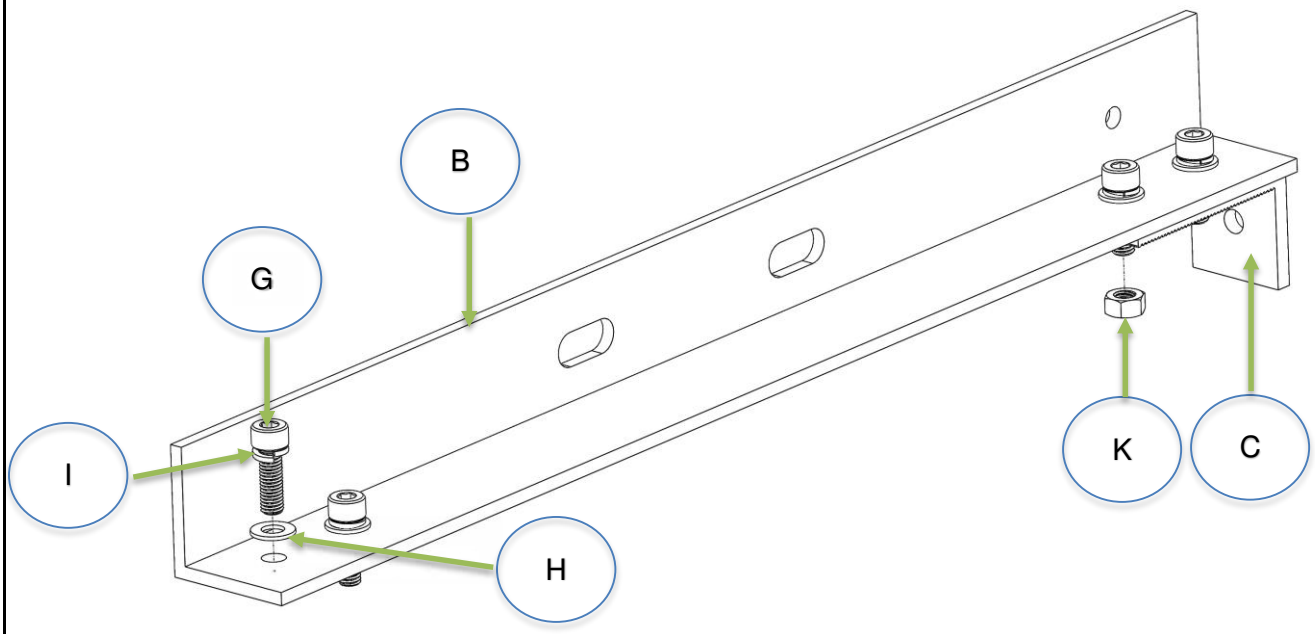


Figure 1

Slide U-Bolt through back face of L-Channel

A. Hold the assembled system up to pole so that L-Channel (B) back face is flush to surface of the pole and slide the U-Bolt (E) through the holes.
B. Fasten U-Bolt (E) with a large washer (L) and 1 or 2 nuts (M) (depending on how much thread is available.
C. Repeat for bottom L-Channel and last U-Bolt.

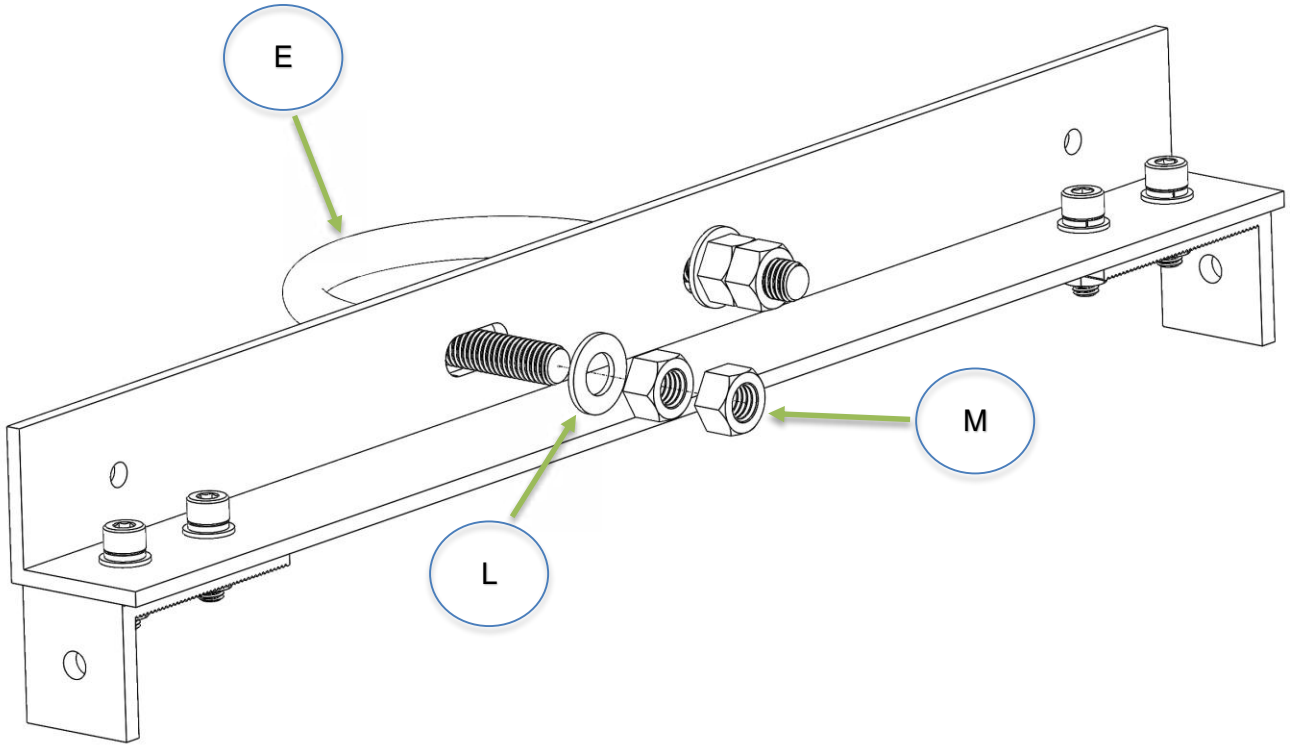


Figure 2

Attach Support Arm to bottom L-Brackets

A. Flush Support Arm (D) to L-Bracket (C) and align the holes.

B. Place washer on Support Arm (D) surface and align holes.

C. Feed a Cap Head Bolt (G) through Support Arm (D), and the L-Bracket (C).

D. Fasten it with small Nuts (K).

D. The orientation should be close to **Figure 3**.

E. Repeat for the other side.

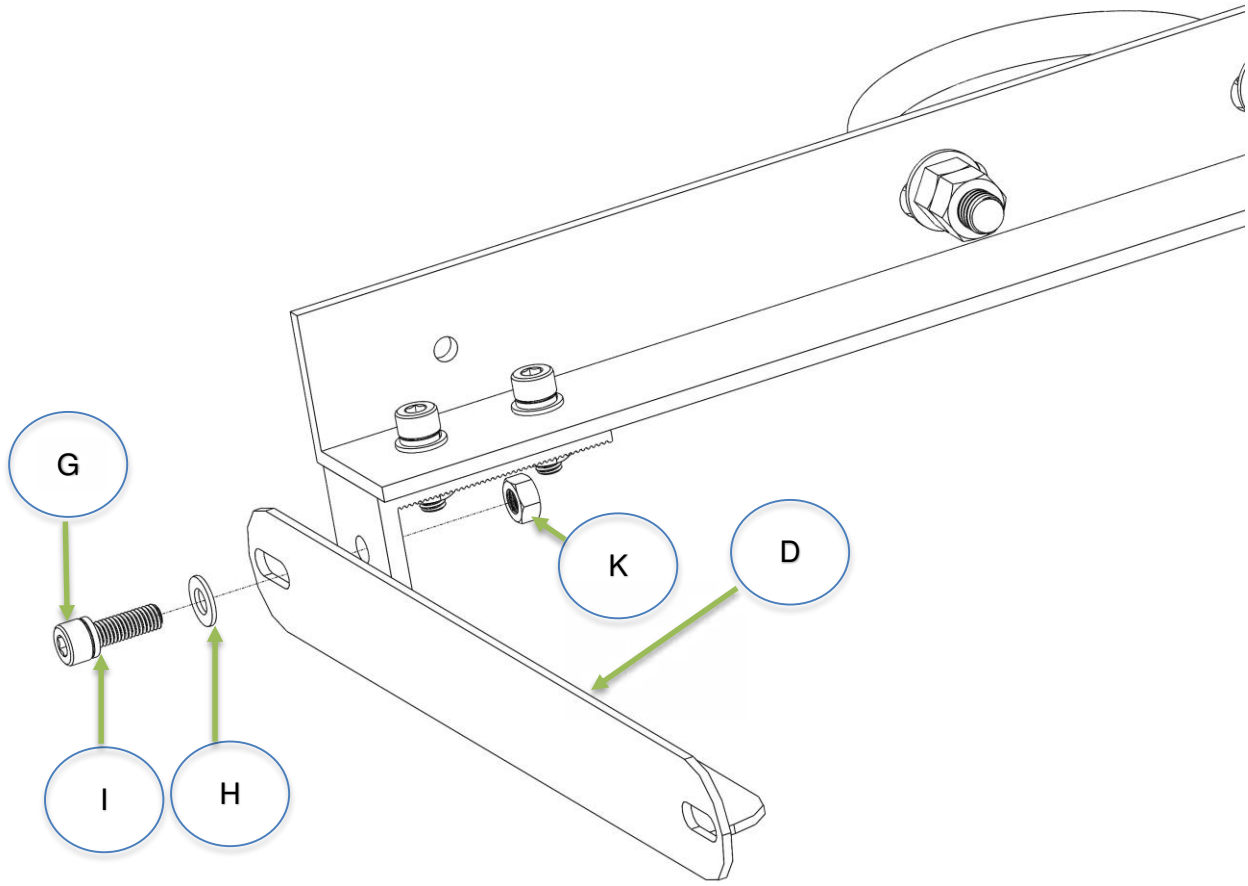


Figure 3

Note: The reason for this is that depending on the angle that the T-Slotted brackets are fastened to the top L-Channel, you may need to adjust the bottom L-Channel so that it will be flush against the pole.

Fasten T-Slotted Brackets to top L-Channel using the L-Brackets

A. Slide T-Bolt (F) through the top of the T-Slotted Bracket (A) approximately 35mm (1.4in) down. There is no need to place a spring washer, or regular washer through the T-bolt.
B. Feed thread of the T-Bolt (F) through L-Bracket (C) and angle T-Slotted Bracket (A) as desired. The optimum angle will vary with your apparent position, relative to the sun. Range is usually from 60-75 degrees from the vertical.
C. Once desired angle has been achieved, fasten the T-Slotted Bracket (A) down with bolt. Be careful not to tighten too much, because it is possible to strip the T-Bolt.
D. Repeat process for both T-Slotted Brackets.

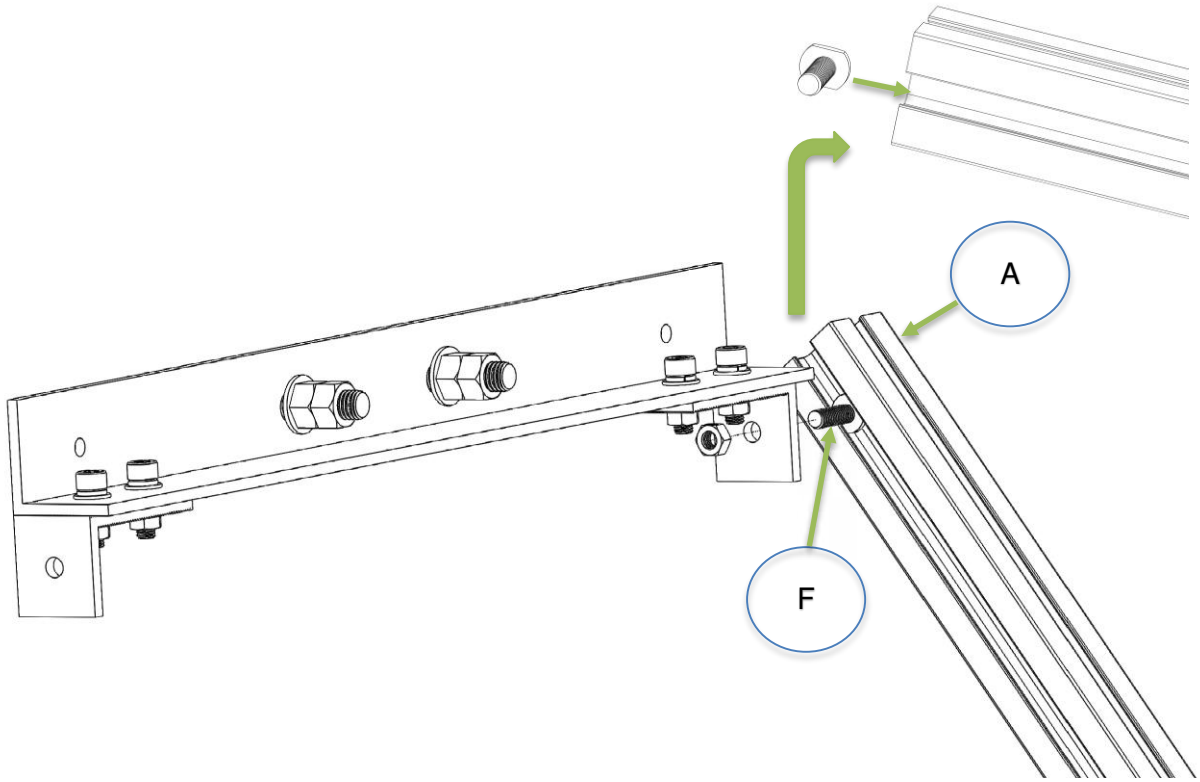


Figure 4

Note: It is important that the T-Slotted Brackets stay parallel. Nonparallel T-Slotted Brackets will cause the panel to bend which can cause micro-fractures in panel.

Fasten the bottom of the T-Slotted Brackets to Support Arm

A. Slide T-Bolt (F) through same slot as previous step. The distance that the bolt should slide depends on the angle that the T-Slotted Bracket (A) was fastened to the top L-Channel (B). Usually anywhere from 150mm to 250mm (6in to 9.8in) although it can exceed that if necessary.
B. The back planes of both L-Channels (B) should be parallel and flush to the pole. Achieving this may require reorienting the T-Slotted Bracket (A). It is recommended to fasten the Support Arms (D) to the T-Slotted Brackets temporarily until you can attempt to orient the assembly on the desired pole.
C. Once the assembly has been temporarily fastened, and is now near the pole, attempts can be made to attach the Pole Mount to the Pole.
D. If the backs of the L-Channels (B) are not flush to the pole surface, adjust the Support Arm (D) angle as needed until the desired angle is achieved.
E. Once desired angle has been achieved fasten the Support Arm (D) to T-Slotted Bracket (A) with a small Nut (K).

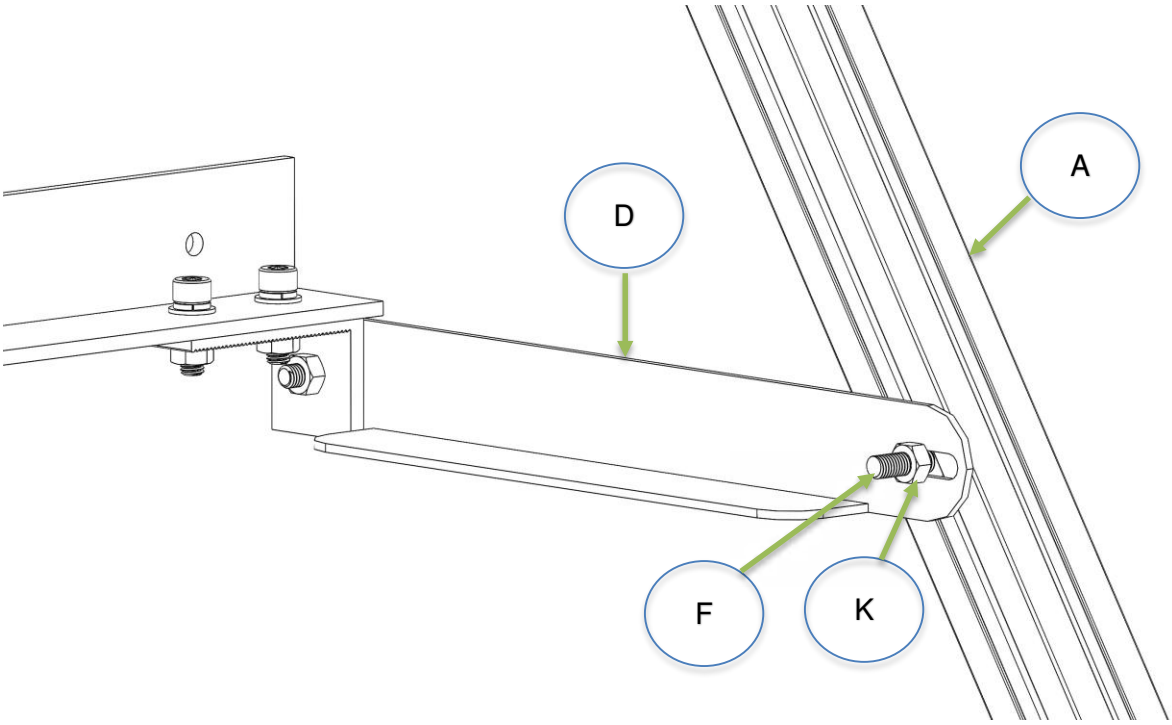


Figure 5

Slide panel onto brackets and fasten with end lamps

A. Hold the panel up to the pole mount to determine approximate position that End Clamps (J) must be to hold panel.
B. Start with the bottom clamps since they will hold most of the load.
C. Slide a T-Bolt (F) through T-Slotted Bracket (A) to the appropriate location.
D. Orient the clamps as they are in **Figure 6**.
E. Once End Clamps (J) and in a position to hold the panel, slide the panel onto the bracket, slide the End Clamp over the edge of the panel so that the surfaces are flush as shown in **Figure 7**.
F. Fasten the End Clamp with a Nut (K) and Washer (H).
G. Repeat for the other bottom End Clamp, followed by the two top End Clamps.

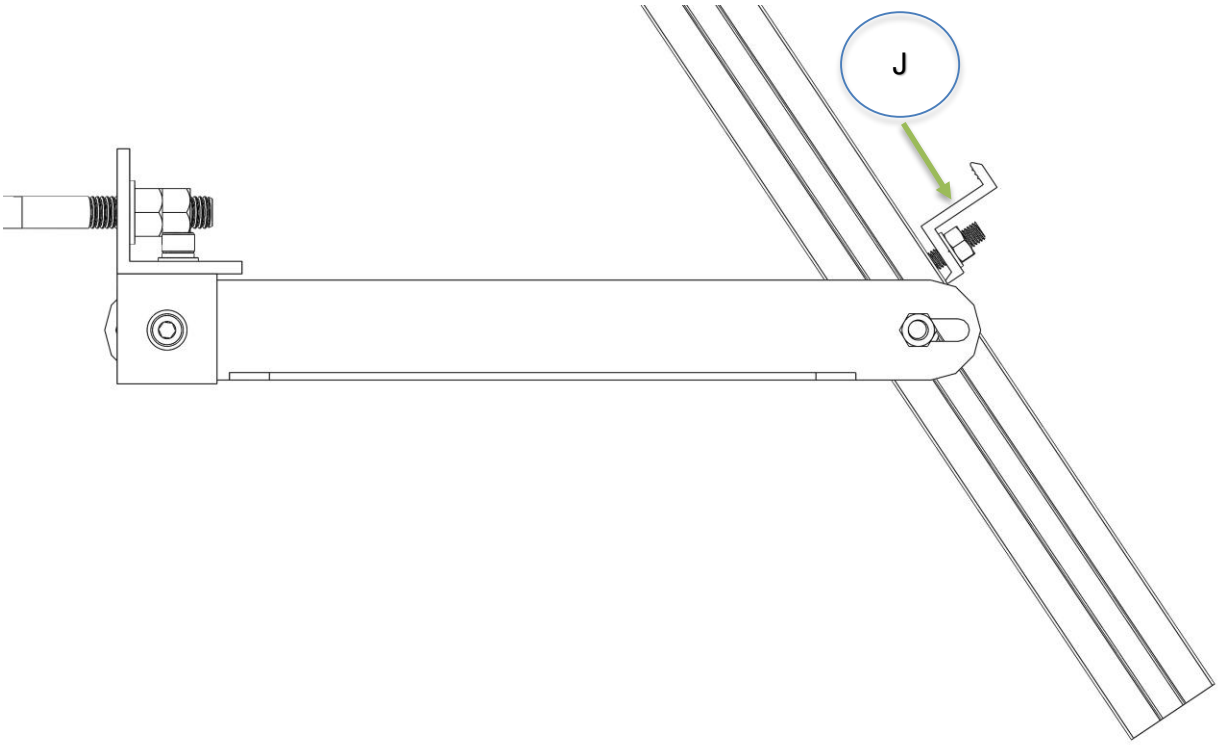


Figure 6

NOTE: This is what the clamp should look like when it is fastened to the panel. Also note that the thread length may not be as long as shown, but will still work.

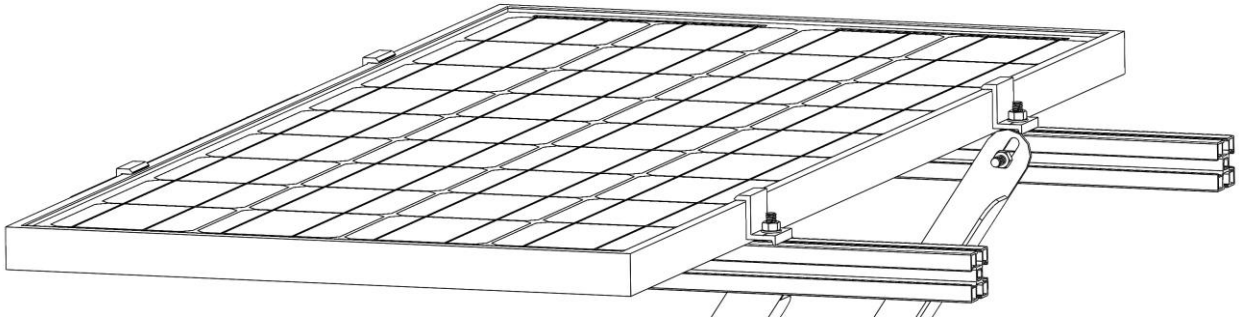


Figure 7

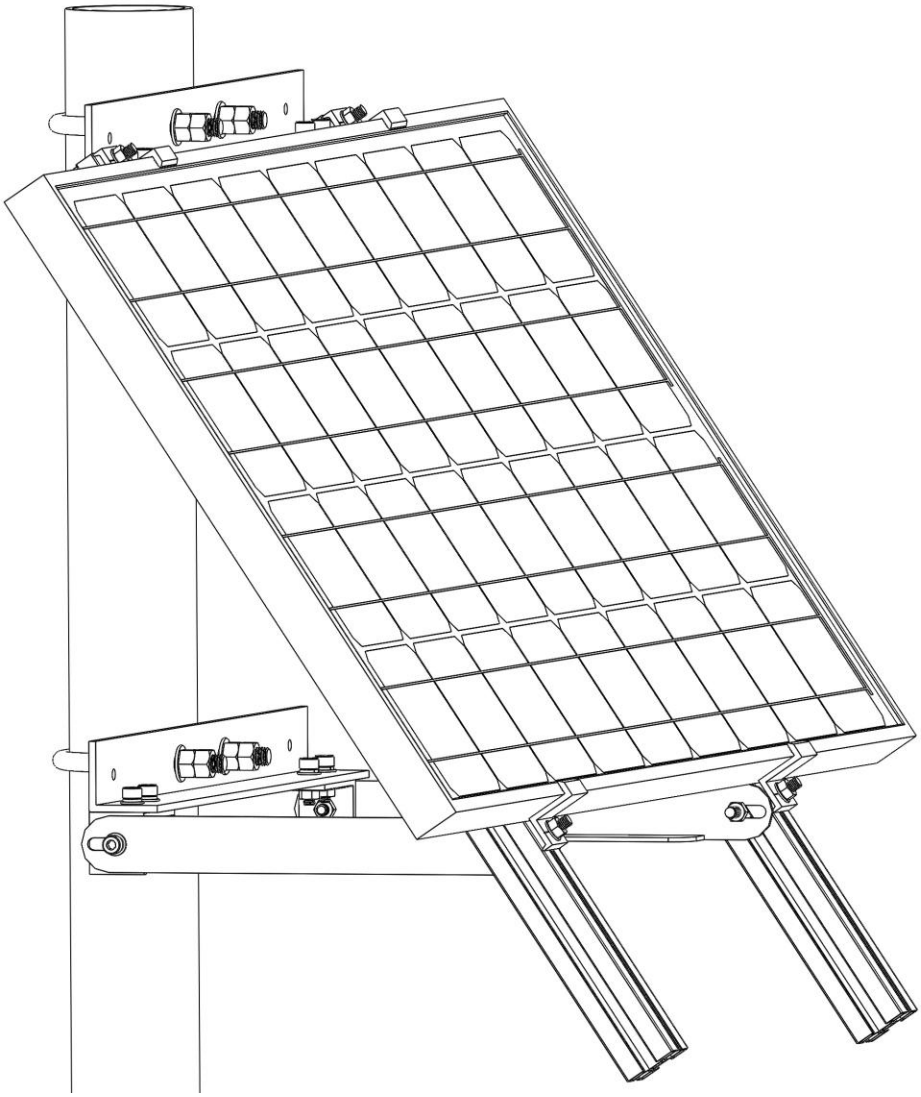


Figure 8

MC4 Connectors

The Positive (+) and Negative (-) outputs of a solar panel are fed through a watertight junction box. The appropriate wire length is wired to the junction box for further connections. The solar panels supplied in each kit are provided with approximately 3 ft. each of both Positive and Negative wires that are pre-connected to the junction box. The free ends of the wires are terminated with a special type of mating connector also known as an MC4 Connector. These connectors allow for ease in extending the wires for further connections.



Caution!

Please do not cut off the solar panel connectors; the warranty will be voided.

General information about MC4 connectors

Each **RENOGY** Solar Panel will have an MC4 Connector System that consists of male and female connectors. This type of connector system is easy to install and uses a “snap-in” type of safety locking clips to lock the two mating connectors. The “snap-in” feature avoids unintentional disconnection. The mating contacts are sealed against the ingress of dust and water. Specifications are as follows:

- Contact diameter: 4 mm
- Maximum rated current: 30A
- Maximum system voltage: 1000V
- Gauge size: 14, 12, 10 AWG
- Degree of ingress protection when connected and properly locked: IP67
- Temperature range: −40°C to +90°C
- TÜV Rheinland approved

General information about MC4 Connectors

The MC4 Connectors mentioned in this manual have been designated “Male” and “Female” ends based upon the characteristics of the mating contact inserts within the terminals. However, in the solar industry, the “Female” MC4 Connector is used for the **positive (+)** lead of a panel, and the “Male” MC4 Connector its used for the **negative (−)** lead of a panel as shown in Figure 5.2.



Figure 5.1 MC4 Connectors and mating contacts



Figure 5.2 Back view of RNG-100D

Figure 5.2 shows the MC4 Connectors that come preassembled with each **RENOGY** solar panel. When purchasing unassembled MC4 Connectors for custom cabling, it is recommended that the appropriate crimper is used; this will avoid loose connections and create a strong internal contact when mating the MC4 Connectors. An example of a great crimping tool is shown in **Figure 5.3.**



Figure 5.3 Crimping tool (#14-10 AWG)

12V wiring

In this section, we will show the basic 12V and 24V connections for off-grid systems that use a PWM- type controller. Please follow them thoroughly.



Caution!

The battery must first be wired to the charge controller before the solar panel is connected to the charge controller.

6.1 Battery to charge controller

The battery(s) must first be connected to the charge controller before proceeding to any other connections. Most PWM Controllers have automatic battery voltage detection, and the controller must detect what voltage level it will be charging at.

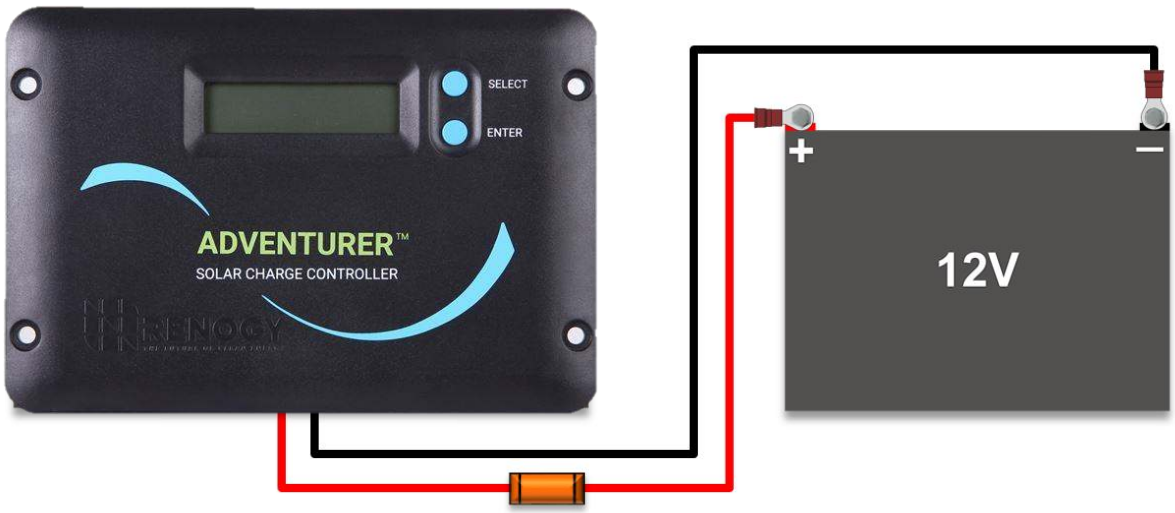


Figure 6.1 Charge controller connected to a 12V battery

Before starting the connection, keep in mind the following:

- The charge controller should be as close as possible to the batteries. This helps keep line loss to a minimum level.
- Remember to always use the recommended gauge size based on the PV system and charge controller.

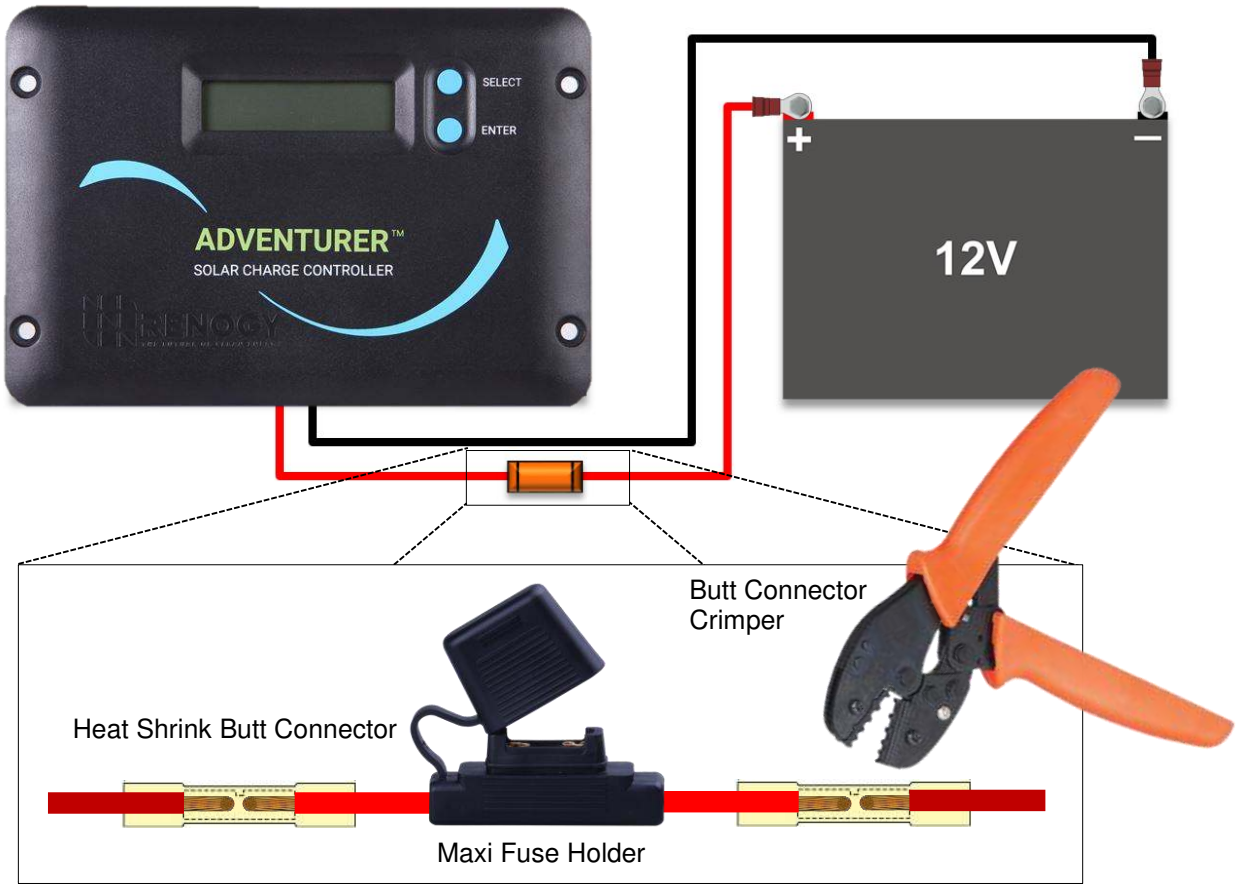
NEC maximum current for different copper wire sizes

AWG	16	14	12	10	8	6	4	2	0
Max. Current	10A	15A	20A	30A	55A	75A	95A	130A	170A

Refer **to Figure 6.1** for connections.

1. First, connect the negative cable to the **negative (−)** battery post. The best way to secure the battery cable to the battery post is by using a **ring terminal**. A bolt is sufficient to secure the ring terminal onto the battery post; doing so will allow for great electrical contact. Next, connect the bare stranded portion of the cable to the **negative (−)** battery input terminal on the charge controller.
2. Similarly to the instructions described above, connect the positive cable to the **positive (+)** battery post. For protection, an in-line fuse can be added to this cable. This is usually done with a fuse holder. If opting for an in-line fuse, please do the following before connecting the **positive (+)** cable to the charge controller:

    - Make sure the fuse holder's gauge wire size is matched.
    - Attach the fuse holder to the line with a butt connector or by soldering it.



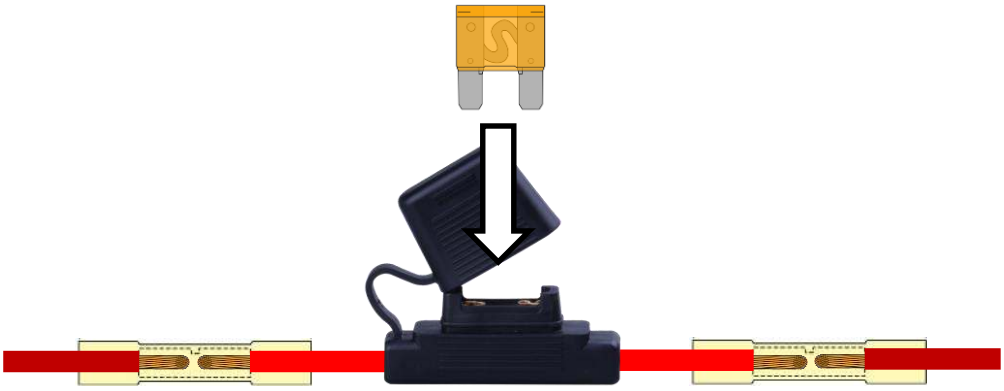
The butt connectors recommended for this application are the type with heat shrink insulation. This will keep will give extra protection for the internal connection.
Use a crimper to splice the Maxi fuse holder with the battery cable. Once a strong connection is achieved, use a **heat gun** to shrink the insulation on the butt connectors.



3. Once the fuse holder is in place, don't attach a fuse just yet. Connect the bare stranded portion of the cable to the **positive (+)** battery terminal on the charge controller.
4. The fuse between controller and battery should be the current rating of the controller. Once the fuse is properly sized, ensure that all connections were made properly, and that there are no loose connections present. Finally, insert the fuse into the fuse holder. **The controller should power on.**

Controller to Battery Fuse = Current Rating of Charge Controller
Ex. 30A ViewStar CC = 30A from Controller to Battery

Maxi blade fuse



5. If opting for **no in-line fuse**, connect the bare stranded portion of the cable to the **positive (+)** battery input terminal on the charge controller directly from the **positive (+)** battery post, bypassing the fuse holder. **The controller should power on.**

Warning!

Be careful not to short the battery. Reverse polarity connection will damage the charge controller and the resulting damage will not be covered by warranty.

6.2 Information about solar panels and PWM Controllers

When connecting a solar panel to the charge controller, please ensure that the correct type of panel or panel array is used.

Please note the following about PWM Controllers:

- 12V panels should be used with 12V battery systems only
- 24V panels or 12V panels configured in series to make 24V should be used with 24V battery systems only
- The solar array should not max out the rated power of the controller. Failure to obey this rule may result in the controller overheating or catching fire.

6.3 Extending the output wires of the solar panel

As we explained in the previous section, **RENOGY** Solar Panels are equipped with cables terminated by MC4 Connectors. To extend these cables, **RENOGY** provides adapter kits as shown in **Figure 6.2**. Adapter kits can be found in Complete Solar Kits or sold as separate components at www.renogy-store.com.



Fig. 6.2. MC4 Adapter Kit

Adapter kits are sold in different lengths, and the basic gauge size is #12 AWG. Unassembled MC4 Connectors can also be purchased separately to make a custom adapter cable suitable for different length specifications.



Caution!

The typical connection for 12V panels using a PWM Controller is a **parallel connection**. This connection increases the current, but keeps the voltage level the same. When placing multiple panels in parallel, it is necessary to size the wire gauge accordingly, and keep the distance between the solar array and the controller as **close as possible**.

Long runs of cable between the panel(s) and the controller increase the line loss if the gauges are not properly sized. We recommend keeping the distance between the solar array and the controller as close as possible. **RENOGY** provides a gauge-sizing tool, available for no charge at:

http://www.renogy-store.com/category-s/1864.htm

Please refer to **Figure 6.3**. This figure shows the extending of the output wires of the RNG-100D Solar Panel using the adapter kit. The polarity labeled on the panel's leads should be the only ones to follow. When adapting the leads, mark the **positive (+)** cable; doing so will avoid reverse polarity when connecting the panel(s) to the controller.

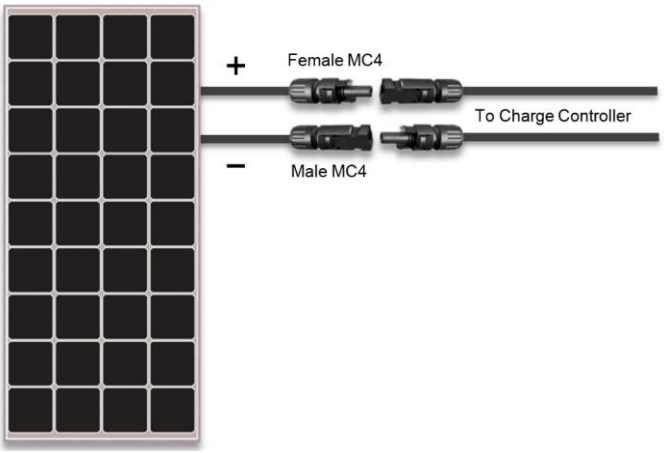


Figure 6.3 Solar panel and adapter kit

6.4 Solar Panel to charge controller

Once the battery is connected to the charge controller and the panel(s) are positioned and mounted in the desired location, we are ready to connect the panel(s) to the charge controller. Panels should be mounted in a place that is free from shading by neighboring obstacles such as vents, air-conditioners, TV antennas, etc.



Hazard!

The panel MUST be covered with a dark cloth to prevent the solar cells from producing energy; this will prevent and reduce shock hazard, which can be life threatening.

Please refer to **Figure 6.4** when completing the following connections:

1. First, mate the “Male” MC4 Connector from the solar panel that has the **negative (−)** label with the “Female” MC4 Connector of your adapter kit as shown in **Figure 6.4**. Then connect the bare stranded portion of the cable to the **negative (−)** solar input terminal on the charge controller.
2. Next, mate the “Female” MC4 connector from the panel that has the **positive (+)** label with the “Male” MC4 connector of your adapter kit as show in **Figure 6.4**.
3. The **positive (+)** solar cable can be fused for protection; an in-line fuse can be added to this cable in the same way as described in the instructions for battery to controller connection. Please refer to section **6.1** and follow the same procedure on how to add an **in-line fuse**.
4. Once the fuse holder is in place, don’t attach a fuse just yet. Connect the bare stranded portion of the cable to the **positive (+)** solar terminal on the charge controller. Ensure that all connections are made properly, and that there are not any loose connections present. Finally, insert the fuse into the fuse holder and remove the protective cloth. If there is enough sunlight present, the controller will start charging the battery (ies).
5. If opting for **no in-line fuse**, connect the bare stranded portion of the adapter cable to the **positive (+)** solar input terminal on the charge controller. Remove the protective cloth. If there is enough sunlight present, the controller’s solar LED indicator/icon on the LCD display should show that it is now charging your battery(s).

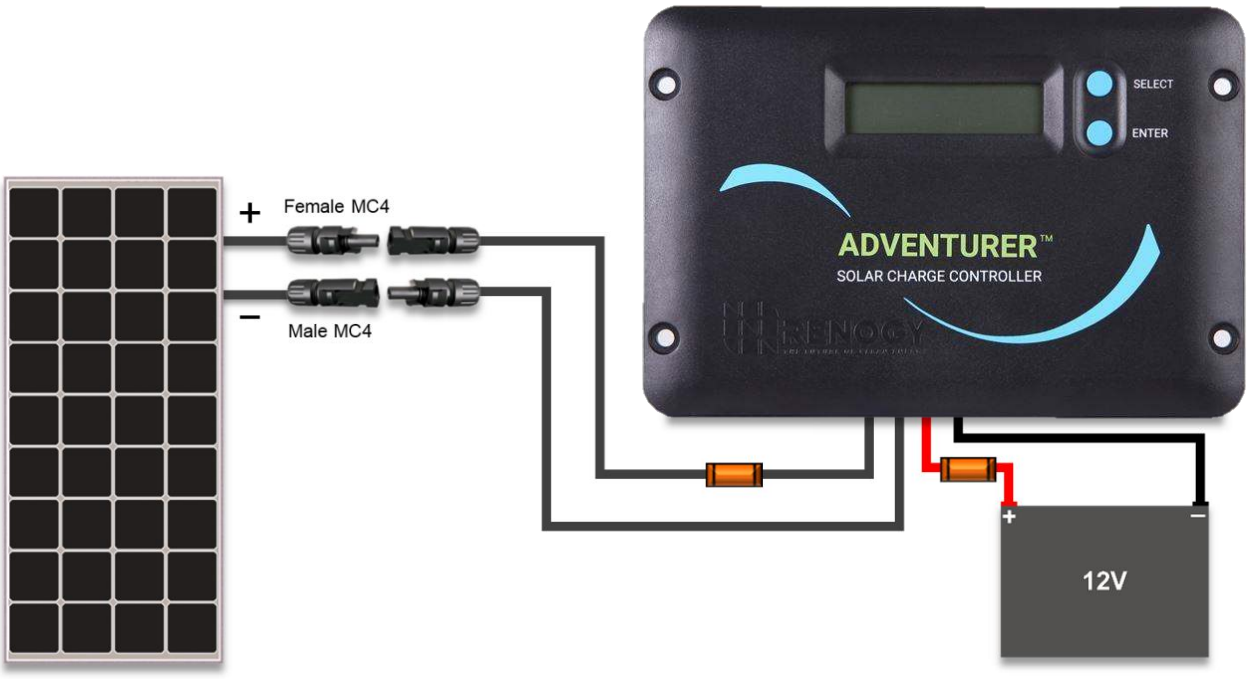


Figure 6.4 Completed 12V off-grid system

Figure 6.4 shows the complete wiring of a typical off-grid system. It includes fuses for safety and protection. This configuration shows only one panel and one battery connected to the controller. In **Sections 8 and 9,** more panel and battery configurations (respectively) will be described. Instructions will follow.

24V wiring

7.1 General information

In this section we will show the basic connections for a 24V battery system. Please follow them thoroughly.



Caution!

The batteries must first be wired to the charge controller before the solar panel is connected to the charge controller.

As we mentioned in last Section, the battery bank must first be connected to the charge controller before any other connections are made. This will allow the controller to set the 24V charging parameters automatically.

Before starting the connections keep in mind the following:

- The charge controller should be as close as possible to the batteries. This helps keeping line loss to a minimum level.
- Remember to always use the recommended gauge size based on the **total** input current. The PWM 30A LCD controller can handle gauges up to 6 AWG.

NEC maximum current for different copper wire sizes

AWG	16	14	12	10	8	6	4	2	0
Max. Current	10A	15A	20A	30A	55A	75A	95A	130A	170A

Please note the following about PWM controllers running in 24V configuration:

- 24V panels or 12V panels configured in series to make 24V should be used with 24V battery system only
- It is not recommended that you charge a 12V battery system with a 24V solar array. Doing so will result in a performance loss of 50%.
- The solar array should not max out the rated power of the controller. Failure to obey this rule may result in the controller overheating or catching fire.

7.2 Overall system connections

Please refer to **Figure 7.1** for the overall wiring diagram for a 24V system.

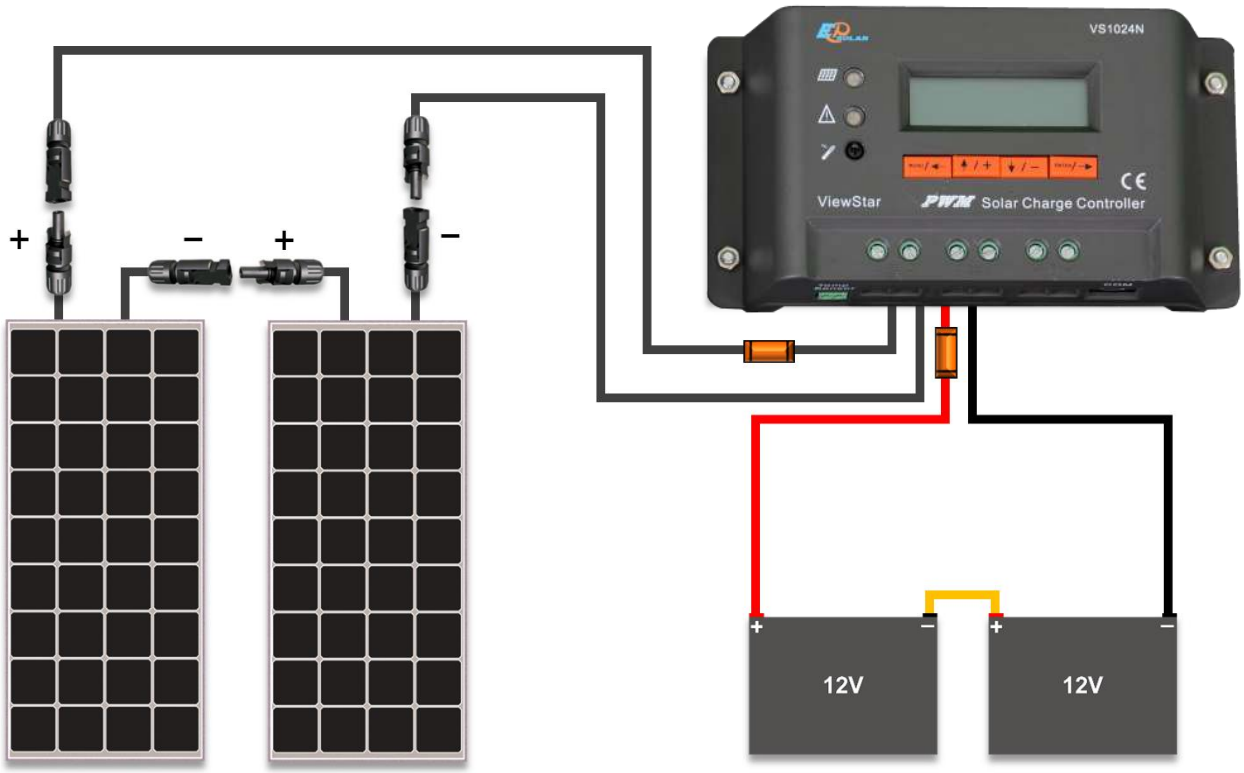


Figure 7.1 Completed 24V off-grid system

As you can see from **Figure 7.1**, the batteries are configured in 24V by placing two **identical** 12V batteries in series. Likewise, the solar array is configured in 24V by placing two **identical** 12V panels (e.g. RNG-100D) in series.

The connections for a 24V off-grid system are very similar to those of a 12V connection. The process should be followed in the same way as outlined in Sections 6.1 to 6.4. The only difference is that the fuse selection changes, since a series connection increases the system Voc to ~45v. Therefore a fuse with a voltage rating of **50v or higher** is recommended, since Maxi and ATO blade fuses have a maximum voltage rating of 32v.

With this being said, the same steps for a 12V system should be followed. Please read Sections 6.1 to 6.4.

Multiple panels/strings in parallel

A parallel connection is achieved by joining all of the positive (+) and negative (-) nodes together. When placing panels in parallel, it is recommended that the voltage levels are within specification. In other words, the V_{mp} (maximum power voltage) of the panels must all be within 10% of each other. Typically, connecting panels in parallel is achieved through using **identical** panels. A simple way to place panels/strings in parallel is by using a branch connector, shown in **Figure 8.1**.



Figure 8.1 Pair of MC4 Branch Connectors



Caution!

Remember to always use the recommended gauge size based on the **total** array current. Sizing the cable incorrectly may result in melting wires and/or fire.

8.1 Two adjacent panels in parallel (12V systems)

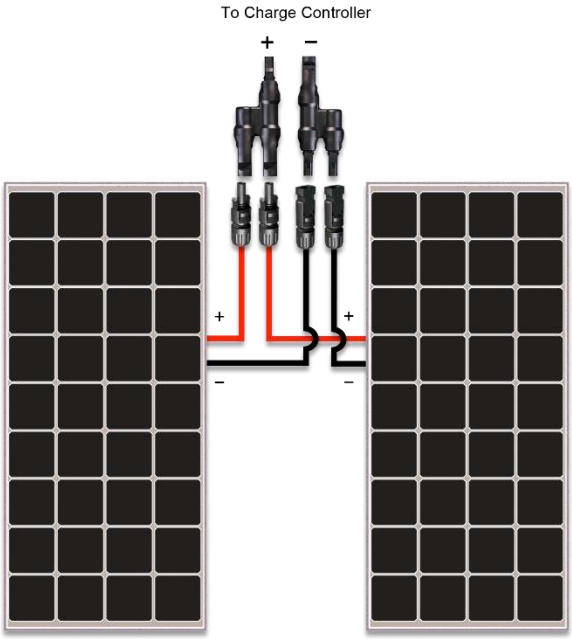


Figure 8.2 Two RNG-100D Panels in parallel

One of the most basic solar configurations involves wiring two solar panels in parallel. This parallel configuration will increase the current output while the output voltage remains the same. **Fig. 8.2** above shows the arrangement for connecting two solar panels in parallel with one pair of MC4 Branch Connectors. This arrangement is applicable if two solar panels will be mounted adjacent to one another. This connection requires **one (1)** pair of MC4 Branch Connectors. When the panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

8.2 Three adjacent panels in parallel (12V systems)

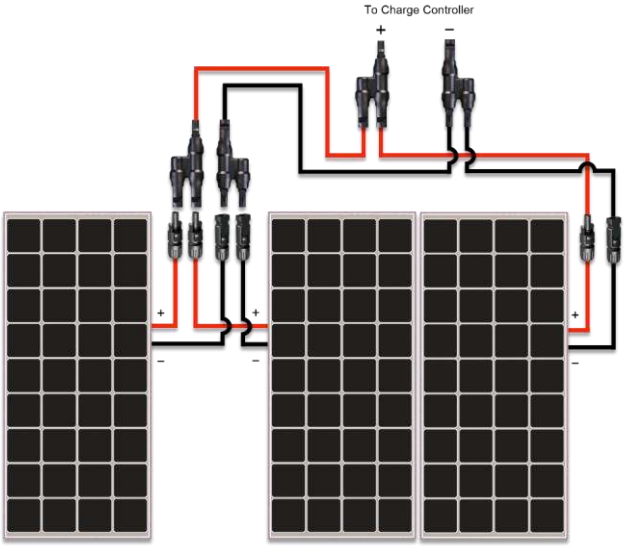


Figure 8.3 Three RNG-100D Panels in parallel

Three solar panels is the maximum amount of panels that can be connected in parallel if they are adjacent to one another, without using extra cabling. **Fig. 8.3** above shows the arrangement for connecting three solar panels in parallel. Remember that this arrangement is applicable if the three solar panels are to be mounted adjacent to one another. This connection requires **two (2)** pairs of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels need to be extended with MC4 Extension Cables (sold separately).

8.3 Four panels in parallel (12V systems, 2x2 configuration)

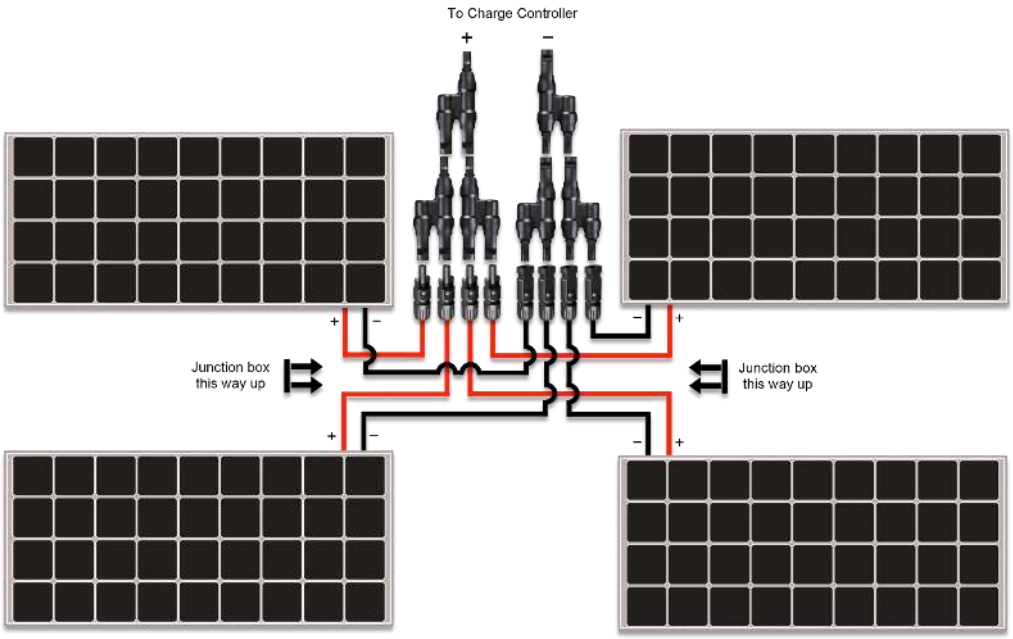


Figure 8.4 Four RNG-100D Panels in parallel

Fig. 8.4 shows the arrangement for connecting four solar panels in parallel. This arrangement is applicable if the solar panels are to be mounted in a **2x2** configuration as shown above. Please note that the positioning of the junction boxes must be followed for the cables to reach the MC4 Branch Connectors. This connection requires **three (3)** pairs of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

8.3 Four panels in parallel (12V systems, 1x4 configuration)

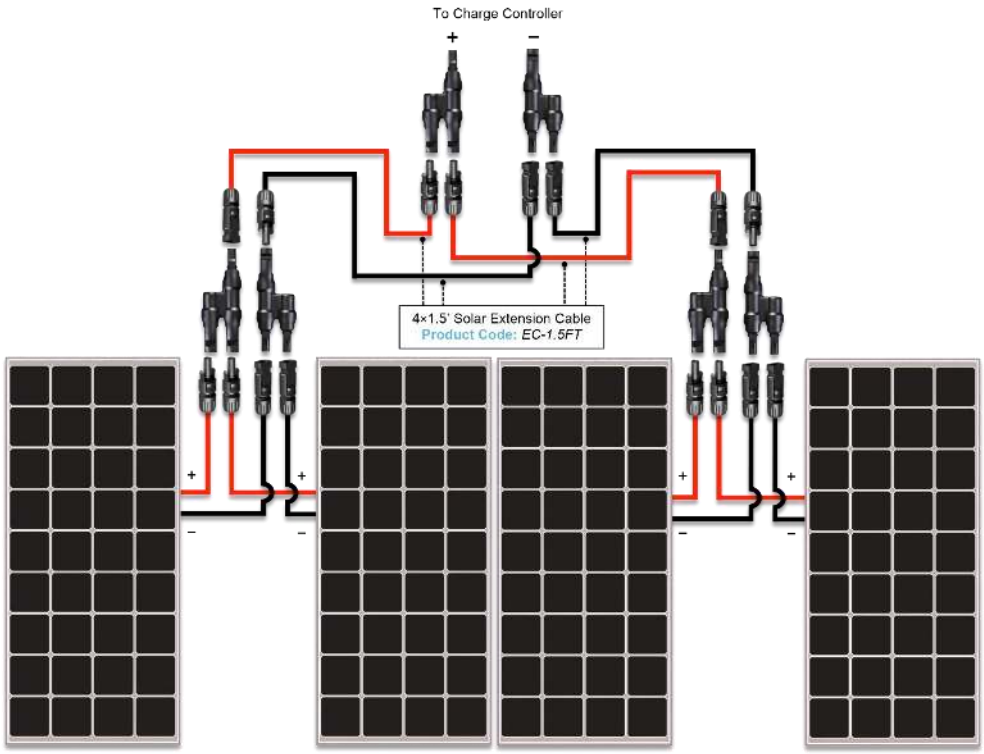


Figure 8.5 Four RNG-100D Panels in parallel

Fig. 8.5 above shows the arrangement for connecting four solar panels in parallel. This arrangement is applicable if the solar panels are to be mounted in a **1x4** configuration as shown above. For this configuration you will need to purchase 4x1.5' MC4 Solar Extension Cables. This connection requires a **three (3)** pairs of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

8.4 Four panels in series-parallel (24V systems, 2x2 configuration)

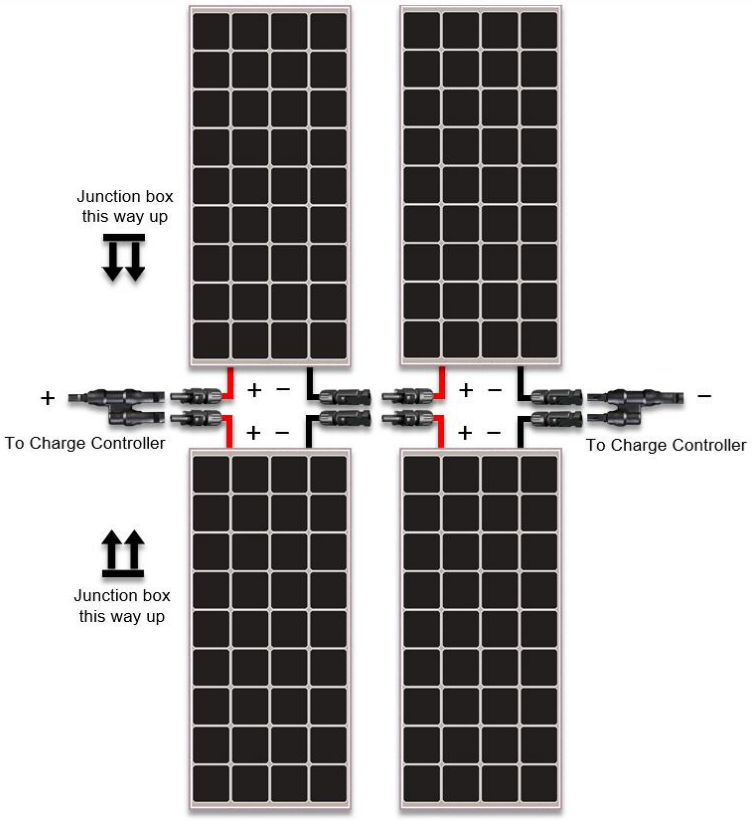


Figure 8.6 Four RNG-100D Panels in series-parallel configuration

For 24V systems, **Fig. 8.6**. Shows two strings of panels in parallel. Each string consists of two panels in series. No additional cabling is required if the solar panels are to be mounted in a **2x2** configuration as shown above. Please note the orientation of the junction boxes. This connection requires a **one (1)** pair of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).



Note

This 24V array can only be used with a 24V battery configuration when using a PWM Controller. Please do not use it with a 12V battery system.

Battery Configurations

The battery system can also be configured to create a “bank” of batteries. In this section, we cover the most basic configurations. When wiring batteries, extreme attention should be given. Never short a battery, as high currents can cause severe burns or even death.



Hazards!

It is recommended that insulated/non-conducting tools be used when working with batteries. Never leave tools on top of the battery. Always wear eye protection. Never touch both of the battery terminals at the same time with your bare hands.

9.1 Series connection of batteries (12V)

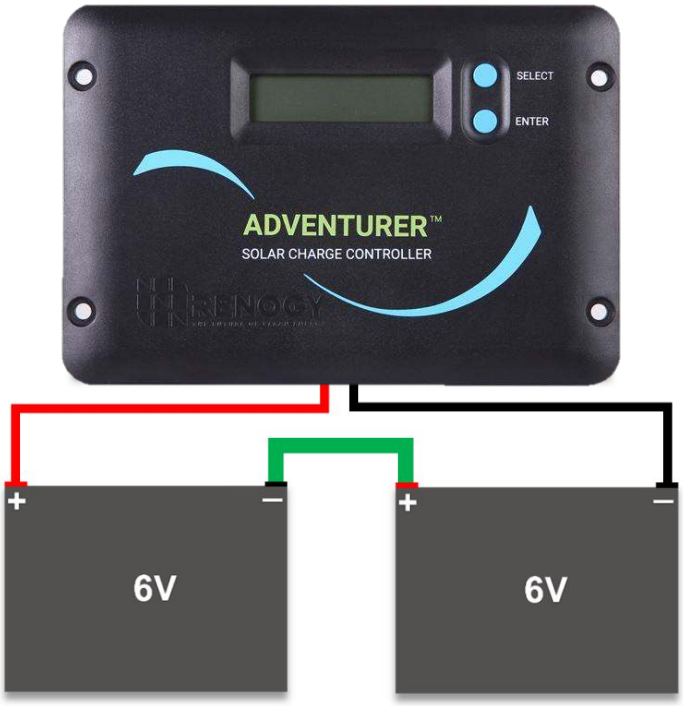


Figure 9.1 Two 6V batteries connected in series

When two or more batteries are connected in a series, their voltages add up, but the Amp-Hour (AH) capacity remains the same. **Fig. 9.1** shows two 6V batteries in series. For example, say each battery has 225 Ah. This wiring will form a 12V battery bank with a capacity of 225 Ah. Notice that the cables connecting the batteries in series are of heavier gauge than the ones coming from the controller. These cables have to be of heavier gauge because when power is drawn from an inverter, it involves large amounts of current. This interconnection cable is often sized according to the power of the inverter.

9.2 Parallel connection of batteries (12V)

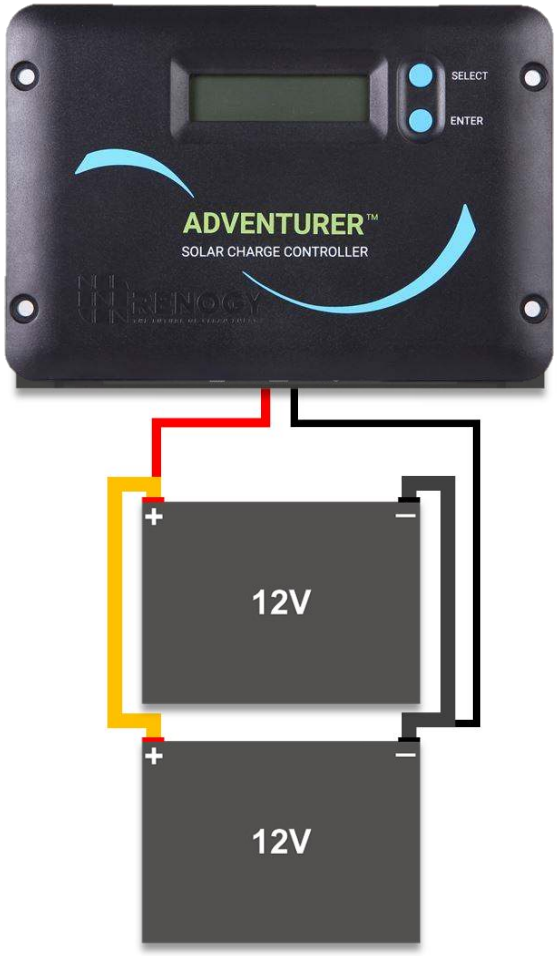


Figure 9.2 Two 12V batteries connected in parallel

When two or more batteries are connected in parallel, their voltage remains the same but the Amp-hour ratings add up. **Fig. 9.2** shows two 12V batteries in parallel forming a “bank”. For example, say each battery has 100 Ah. When connected in parallel they will form a battery bank of 12V with a capacity of 200 Ah. Notice that the cables connecting the batteries in parallel are of heavier gauge than the ones coming from the controller. These cables have to be of heavier gauge because when power is drawn from an inverter, it involves large amounts of current. This interconnection cable is often sized according to the power of the inverter.
The negative cable from the controller to the battery should be placed at the opposite end of the battery bank. **Figure 9.2** shows this connection.

9.3 Series – Parallel connection of batteries (12V)

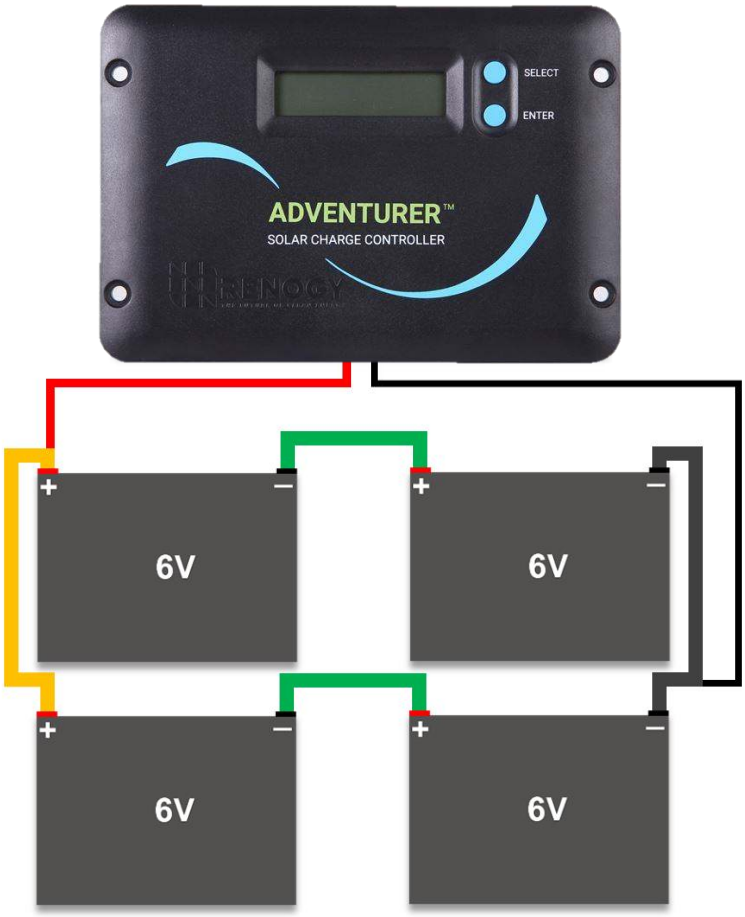


Figure 9.3 Four 6V batteries connected in series – parallel

Fig. 9.3 shows two strings in parallel; each string consists of two 6V batteries in series. For example, say each battery has 225 Ah. Each string would have a voltage of 12V with a capacity of 225 Ah. When these strings are paralleled, the total capacity of the battery bank will be 12V at 450Ah. Notice that the cables connecting the batteries in series and parallel are of heavier gauge than the ones coming from the controller. These cables have to be of heavier gauge because when power is drawn from an inverter, it involves large amounts of current. This interconnection cable is often sized according to the power of the inverter.
Also, the negative cable from the controller to the battery should be placed at the opposite end of the battery bank. **Figure 9.3** shows this connection.

9.4 Series connection of batteries (24V)

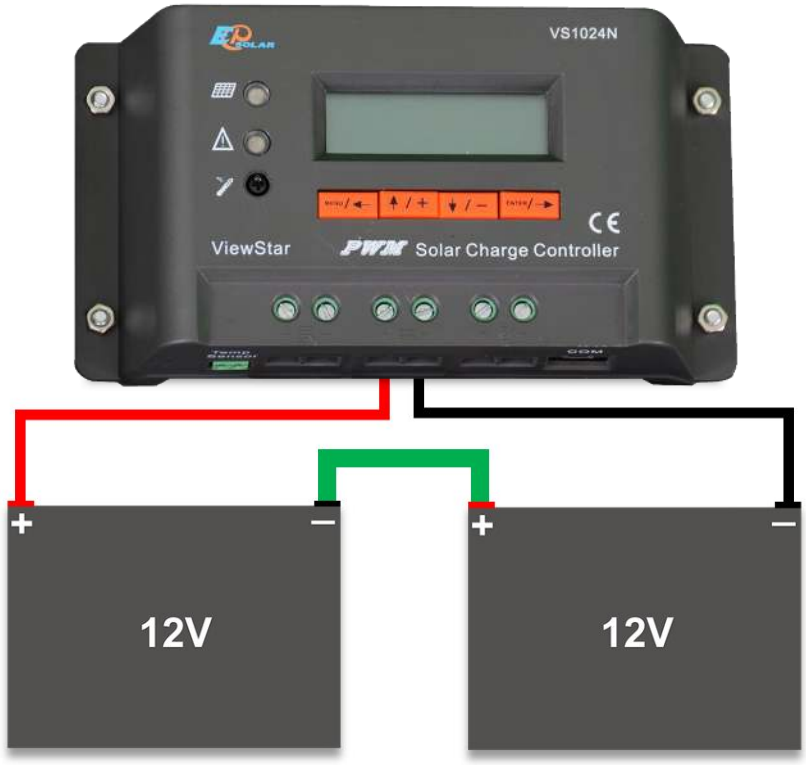


Figure 9.4 Two 12V batteries connected in series

Wiring two 12V batteries in series as shown in **Fig 9.4** will result in a 24V system. The same idea applies if you place four 6V batteries in series (**Fig 9.5**). Remember that when batteries are in series, the voltages add, but the total capacity of a string of batteries stays the same. For example, if two 12V batteries with 150Ah rating are wired in series, the resulting system would be 24V at 150Ah. **Because of this, it is mandatory that the batteries are identical when they are wired in series.**

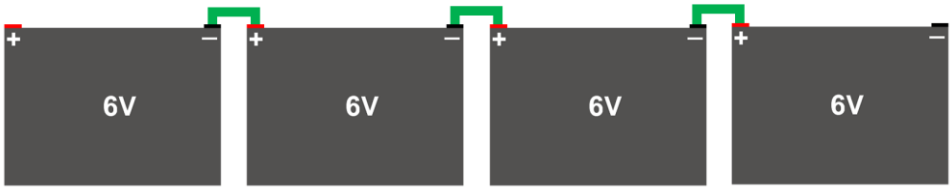


Figure 9.5 Four 6V batteries connected in series

9.5 Series-Parallel connection of batteries (24V)

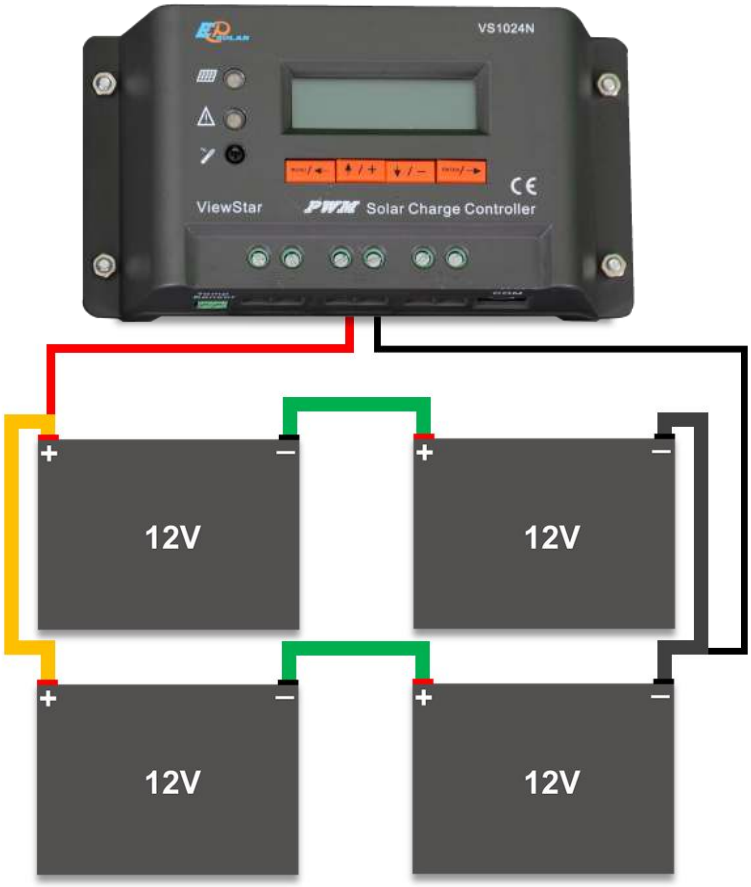


Figure 9.6 Four 12V batteries connected in series – parallel

Multiple strings of batteries can be wired in parallel to increase the capacity. **Figure 9.6** shows a battery bank with two strings of batteries. Each string consists of two 12V batteries in series. For example, if wiring four 12V/150Ah batteries like as shown in Figure 9.6, then each string will have a total capacity of 24V/150Ah. By paralleling these strings, the total capacity would be 24V/300Ah. **Because of this, it is mandatory that the batteries are identical.**
Each parallel string can also consist of 4x6V batteries to make 24V per string as shown in **Figure 9.5**. Remember that the negative cable from the controller to the battery should be placed at the opposite end of the battery bank.

Inverter Wiring

10.1 General information about power inverters

A power inverter, or inverter, is an electrical device that changes direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits.

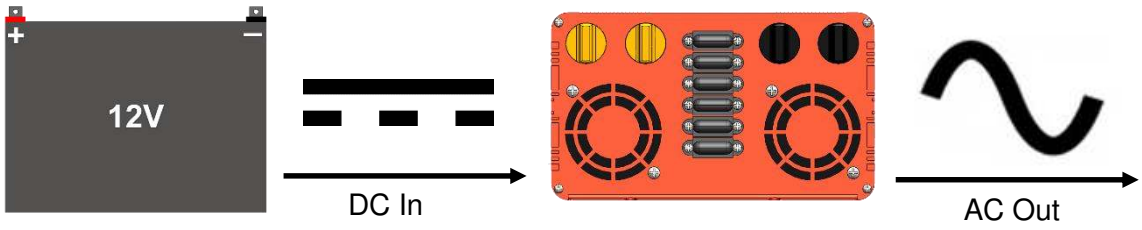


Figure 10.1 Simple diagram on how the inverter works



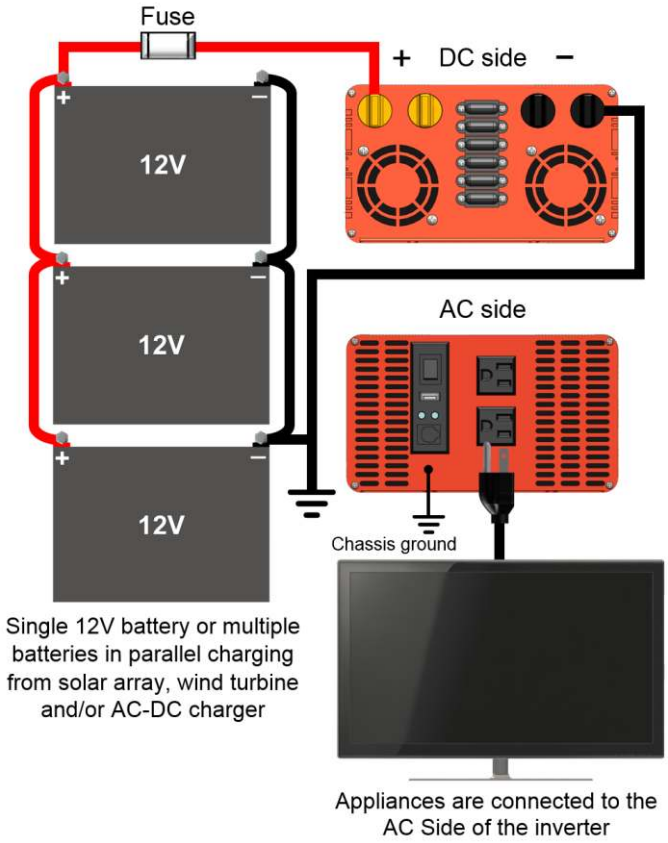
Warning!

Please read these instructions carefully before attempting to carry out any installation and wiring. Contact Technical support for any questions concerning the installation.

This equipment should be installed, adjusted, and serviced by qualified electrical maintenance personnel familiar with the construction and operation of solar/electrical equipment and the hazards involved. Failure to observe this precaution may result in bodily injury and/or damage to property.

10.2 Wiring instructions

Step 1: Select the right input voltage
Input voltage can be 12V/24V/48V depending on which products are used. It is recommended that the inverter be powered by a battery or battery bank, as the current drawn from the inverter can become extremely high.
Step 2: Connecting inverter to battery
Set the switch to **OFF** position (inverter and appliances). Connect the battery cables to their respective colors on the inverter i.e. black cable goes to the black terminal on the inverter, and the red cable goes to the red terminal on the inverter.



Please refer to **Fig. 3**. Each end of the battery tray cables should have a “ring terminal” type of connector. These connectors make it easy to achieve a secure and strong connection. Once the cables are connected and bolted down to the inverter, connect the black cable to the negative post of the battery (-). Then, connect the red cable to the positive post of the battery (+). If connecting to a battery bank, make sure that the black cable connects to the negative battery post (-) at the end of the bank (opposite to the positive battery post as shown on **Fig. 3**). It is recommended that a fuse be placed on the hot line (positive) between the battery and inverter. Please refer to **the owner’s manual** for the proper wire gauge size and fuse ratings for each inverter.

Figure 10.2 Inverter wiring diagram



Ground!

The negative battery terminal and the chassis ground of the inverter should be connected to a system ground. This is a safety measure to prevent electrical shock!

NOTE: **The charge controller and the inverter should be connected to the same battery terminals (same connecting points shown in Figure 10.2), no exceptions.**

Step 3: Connecting electrical appliances to inverter



Caution!

Make sure the power load is within the rated power of the inverter. The start power of the appliances should not exceed the peak power of the inverter.

Once the devices are connected to the AC outlet, they are ready to be powered. When the inverter is not in use, it is recommended that you turn off the inverter (switch in **OFF** position).