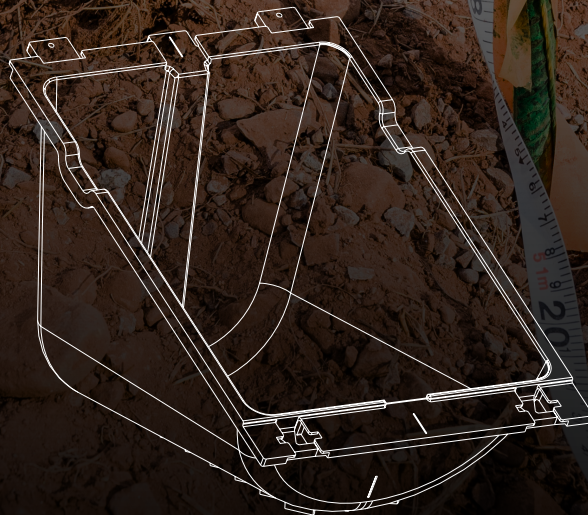


Field Installation Manual

powerfield

PV Ground-Ballasted Solar Array
Using PowerField's "PowerRack"



PATENTED AND MADE IN THE USA
AUGUST 2022

Welcome to PowerField! We sincerely hope you enjoy the many benefits that come from PowerField simple solution for installing solar energy.

The purpose of this manual is to provide installation instructions to the field installer of a PowerField solar array when using our patented PowerRack.

The “PowerRack” is a mounting system suitable for any size of PV ballasted solar arrays.



Figure 1.
PowerRack



Figure 2.
PowerField PV Solar Array

A PowerField installation consists of the following general steps:

1. Permitting and Pre-Approvals
2. PowerField System Design and Engineering
3. Site Preparation (including clearing and leveling if needed/desired)
4. Material Staging, System Layout and Marking Each Row
5. Trenching and Conduit (if the design calls for underground cabling)
6. PowerRack Placement and Alignment
7. PowerRack Filling with Ballast
8. Solar Panel Installation on PowerRacks
9. Electrical Installation
10. Finalize Permits and Approvals

Important: All necessary permits and approvals must be obtained by the installer and/or customer.

WARNING!!: All electrical work should be conducted by qualified personnel, certified or otherwise approved by the appropriate national, state and/or local jurisdictional authorities. The following instructions are provided only as general indications of the steps one would need to undertake to complete the solar array. PowerField is not responsible for the electrical installation of the system and highly recommends that the system be installed by a certified electrician.

PowerField Installation Steps

1. Permitting and Pre-Approvals

- Identify and obtain any permits and pre-approvals that may be required, such as: construction, electrical, environmental, and glare.

2. PowerField System Design and Engineering

- Complete electrical design and equipment selection.
- Complete the wind loading analysis and calculate the ballast requirements.
- Using the results of the wind and ballast calculations complete the physical layout design of the array. This will result in the number and placement of PowerField racks throughout the array.

Design and engineering of a PowerField solar array is similar to any conventional fixed-tilt ground-mount solar facility with a few differences. It is assumed that the owner will have already designed the system and procured the equipment. Part of that process will have resulted in an array layout (Figure 3.) and ballasting diagram. The array layout will show the number of rows, and the number of panels and PowerRacks within each row. The array dimensions, row spacing will have been determined; specification and placement of electrical combiners, disconnects, pull boxes and inverters will have been determined; and the cable trenching plans will have been completed.

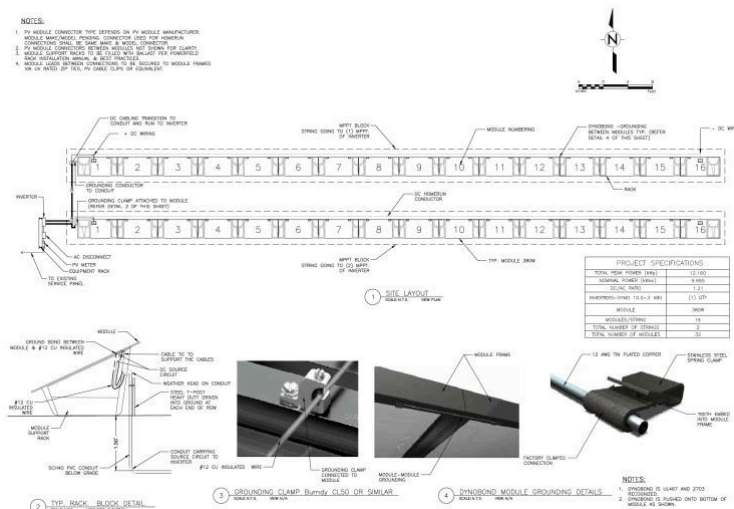


Figure 3.
Example System Design

3. Site Preparation (including clearing and leveling if needed / desired)

- Clear site of surface rocks and debris.
- Smooth and level ground within rows either by moving native soil and rock or by adding and smoothing strips of gravel.

Clearing and leveling the site is the most important step for ensuring smooth and trouble-free mechanical installation of the racking and panels.

PowerField's simple racks can tolerate some amount of unevenness and slope throughout the array, however, the more uniform each row can be graded from end-to-end the more quickly and easily the installation will go.

Ideally, PowerField recommends a slope of no more than 10% from end-to-end within any single row, and no more than 10% from the north side of the array to the south. Each row should be cleared of rocks, bumps, and surface irregularities. However, the PowerRacks can accommodate a steeper slope by using ground anchors, which can be installed from the inside bottom of the PowerRacks prior to ballasting placement.

We have found that for some sites it is simpler to add and smooth a strip of fine gravel or sand within a row rather than work with the native soil and rock. Compaction is not necessary but can help the installation. Final leveling within each row may be done at the same time the PowerRacks are being placed.

The degree to which each row is made uniform in slope and evenness affects the uniformity of the plane of the panel surfaces within the row which in turn affects both the aesthetics of the array and to a lesser extent the energy production.

PowerRacks are versatile in that they can be configured with adjacent panels sharing a rack (Figure 4.) or with each panel being supported by dedicated PowerRacks (Figure 5.). Arrays with PowerRacks shared by adjacent panels should have more care and effort devoted to ground preparation and alignment.



Figure 4.
One panel supported by two PowerRacks
No Ground Leveling is Required



Figure 5.
Adjacent panels sharing PowerRacks
Ground Leveling Recommend / Required

4. Material Staging, System Layout, and Marking Each Row

- At the site, ensure that you have all of the materials and that they are safely and orderly set to the side of where the installation will be.
- In the field, lay out and mark or stake on the ground where each row of panels will start and end. Use the array layout diagram generated for your site during the engineering phase. Using a true-north compass align the rows either east-west, or skewed to the azimuth angle shown in the layout diagram. Clearing and leveling the site is the most important step for ensuring smooth and trouble-free mechanical installation of the racking and panels.

5. Trenching and Conduit (if the design calls for underground cabling)

This step is done if the electrical cabling design calls for underground installation of cables between the ends of rows and combiners or inverter. This can be done before or after the PowerRacks and panels are mechanically installed in the field. For this instruction manual we have assumed this step will be done before placement and assembly of racks and panels.

- Dig trenches for cabling along the side of the array and between the array and the inverter/metering location.
- Install conduit in trenches with risers at the end of each row.
TIP: PowerField recommends that risers be temporarily stubbed and capped at ground level to avoid damage during installation and assembly of racks and panels.
- Backfill trenches (after inspection by the authority with jurisdiction, if required).

6. PowerRack Placement and Alignment

This step should be done for one row at a time.

- Mark a long surveyor's tape measure with intervals the length of your particular solar panels. Mark the number of panels in a row, oriented end to end (landscape).

TIP: This is most easily done with two workers, one to pull and hold the tape across a panel while the other marks each panel-length interval. The marks on the tape should be located at the joints where adjacent panels will abut one another within the rows.

- Starting with the northernmost row, pull the marked tape measure from one end of the row to the other and secure to stakes. Make sure the tape is reasonably taught but don't stretch it.
- Place racks within the row according to the array layout and ballasting diagram using the marked tape to assist.
- Align racks to one another along the entire length of the row. The racks should be aligned laterally, rotationally and vertically at both their high and low ends.

TIP: Partially ballasting each rack at this stage helps to stabilize and prevent the rack from shifting after alignment.

TIP: If the ground in a row is uneven, individual racks can be elevated and adjusted by placing a layer of gravel underneath.

TIP: Alignment is most easily done with one worker sighting from the end of a row and signaling "right-left" "up-down" to other workers walking down the row. Fine adjustments are made by having one worker lift or rock the rack while another scrapes or brushes gravel under or away.

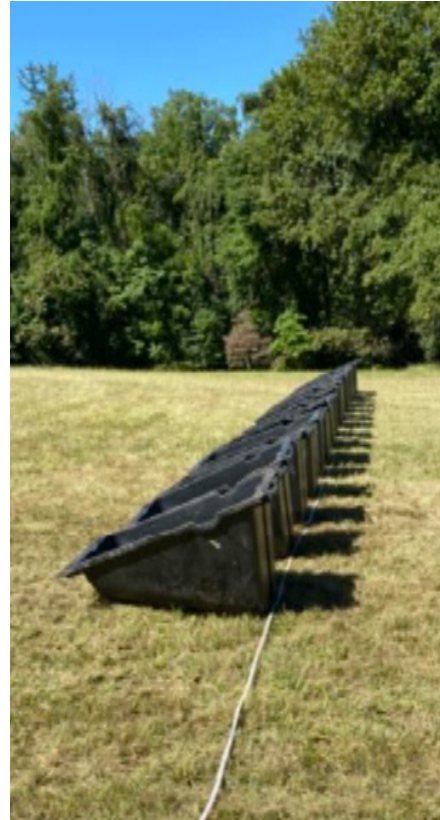


Figure 6.

Properly aligned row of PowerRacks

7. PowerRacks Filling with Ballast

Prior to installation you will have obtained an array ballasting chart prepared by your structural/civil engineer in accordance with the local permitting authority having jurisdiction over structural wind loading design. This chart will specify how many PowerRacks are to be installed, their location and the amount of fill material to be placed in each. Recommended ballast materials include uniform or semi-uniform sized materials such as pea gravel, coarse gravel, crusher run, sand, or dry soil. Using boulders and large rocks with jagged edges as ballasting, particularly in extreme temperature zones, can potentially result in product breakage that falls outside of the product warranty.

The steps for completion of each row consists of:

- PowerField has found that installation is best completed one row at a time, starting with the northernmost row and working south.
- Once the racks in a row have been placed and fully aligned fill each rack with the remainder of the ballast according to the ballasting diagram and the Field Ballasting Installation Manual.

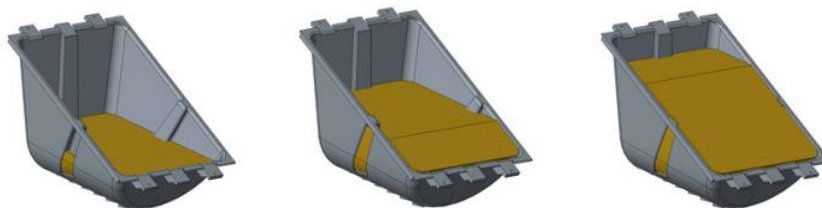
TIP: The best bulk ballast material will be easy to move and shovel, such as coarse sand, pea gravel, or 3/8" gravel or the like. Large, coarse gravel or soil with high clay content or moisture can be difficult to handle.

TIP: For large scale sites a skid steer with a side discharge bucket is ideal.

The following chart (Figure 1) lists the amount of ballast to be placed within a PowerRack in order to achieve the specified weight.

Ballast Depth at Center of Rack	Weight in Sand/Gravel	Notes
7"	200 lbs.	
10"	300 lbs.	
11"	350 lbs.	Even with lower edge of rack opening
13"	400 lbs.	
14"	450 lbs.	

Figure 7. - Ballast Weight Chart



350 lbs.

8. Solar Panel Installation on PowerRacks

The installation of solar PV panels on PowerRacks is designed to require no tools. PowerRacks are designed to hold solar PV panels using slots on the high side that receive the aluminum rail frame on the back side of the panel.

The aluminum frame of the PV panel engages with a slot on the high side of the PowerRack, and the aluminum frame on opposite side of the panel rests on the lower edge of the PowerRack and is secured using simple sliding retainer clips that also require no tools to install.

Figure 8.
PowerRack
View from Above



“High Side”

Support tabs and flanges on the high side together form the slot for receiving the PV panel frame rail flange.

Slots on the low end for the sliding retainer clips

“Low Side”

- Prior to installing panels, you may want to lay a “fishing wire” or line along the full length of the row, resting on the indentations on the tops of the side rails. This will be used to pull the DC home-run cables once the solar panels are installed.
- In teams of two, carry panels one-by-one to the row and install on the racks.
- Rest the low side of the panel on the side rails of the rack and slide down far enough that the high side rail of the panel can engage with the tabs protruding from the lip of the rack.
- Place and engage the panel edge on the high side of the PowerRack(s).

TIP: A worker(s) on the low side can help support the panel from sliding down until the worker on the high side has the panel aligned and ready to slide down so the flange on the panel frame engages with the slots on the high side of the rack.

TIP: Once aligned and resting on the tabs, the worker on the high side can push the panel down the rails until the flange is fully seated in the rack slots.

- After the panels are installed secure the low side using the sliding retainer clips.

Close-up of upper flanges and support tabs which together form the slot for receiving the panel frame rail flange.



Figure 9.
The tabs and flanges forming slot
on the high side of the PowerRack



Figures 10. and 11.
Close-ups of slot for sliding retainer clip



Figure 12.
Worker resting panel on the PowerRack
side rails ready to slide into place.



Figure 13.
Worker lowering the panel onto the high side tabs



Figure 14.
Panel resting on tabs ready to slide down
to seat panel frame flanges in slots.



Figure 15.
Worker pushing panel down into slots.

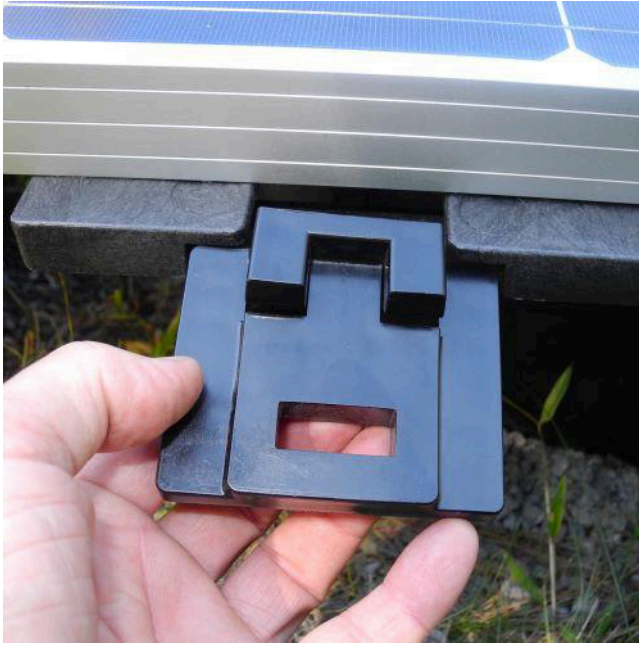


Figure 16.
Panel fully seated in the PowerRack high side slots.

Installing the PowerRack Retainer Clips

Once the panel is properly in place on the PowerRack and frame flange fully seated in the high side slots, install the sliding retainer clips on the low side using the following steps.

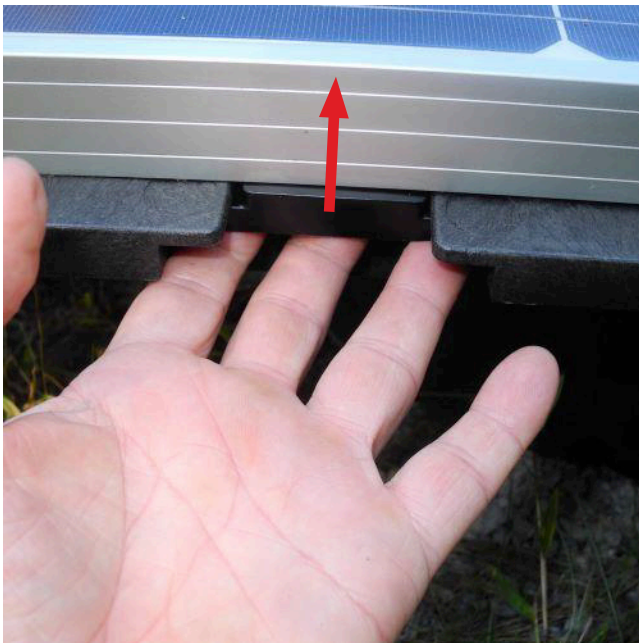
Step 1: Orient clip correctly.



Step 2: Slide clip into slot under frame.



Step 3: Push clip upward into panel.



Step 4: Pull clip towards you.



Figures 17-20.
Installation sequence of the sliding retainer clips.

Installing the PowerRack Security Keys

The final step of the mechanical installation is to insert the security as shown in the following photos.



Figure 21.

Security key ready to snap into place.



Figure 22.

Security key fully seated.

9. Electrical Installation

WARNING!!: All electrical installation work should be conducted by qualified personnel, certified or otherwise approved by the appropriate national, state and/or local jurisdictional authorities. Electrical shock and death may occur by improperly installing or handling electrical equipment. PowerField is not responsible for the electrical installation and only contracts with certified electricians.

The following instructions are provided **only** as general indications of the steps one would need to undertake to complete the solar array.

- If conduits were buried and stubbed off at ground level they should be uncovered and risers, weather heads, conduit boxes, pull boxes, combiner boxes and the like installed.
- Home run cables for each string/row can be pulled using the fish tape placed as described in Section 7 of this manual.
- Install grounding jumpers bonding panel frames to one another.
- If microinverters or optimizers are being used, install them according to the manufacturer's guidelines.
- Appropriate terminations should be installed on DC cables, and transitions from PV cables to conventional cables installed.
- Cables from the end of each row should be fed into the conduit weather heads and pulled to conduit boxes, combiner boxes, inverters, etc.
- Connection of components within the DC system, such as panel pigtail cables, home run cables, junctions, transitions, combiners, inverters and the like should be done following the sequence and methods required by the inverter manufacturer, the utility and any other appropriate national, state and/or local authorities having jurisdiction.
- Installation and connection of the AC system should be done following the sequence and methods required by the inverter manufacturer, the utility and any other appropriate national, state and/or local authorities having jurisdiction.

10. Finalize Permits and Approvals

- Finalize and obtain any permits and pre-approvals that may be required, such as: construction, electrical, environmental, and glare.

Now watch and enjoy as your PowerField racks up savings from the sun!

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