

Installation Manual

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1. General

The TGR System is designed to be installed on a flat or low sloping roof for an array of any size, provided the guidelines within this manual, the project specific construction package and any other applicable codes and standards are followed.

This installation manual, while shown in portrait can apply to portrait or landscape orientation for PV module with frames of sizes up to 45" x 90" provided the project specific design has been completed and the module manufacturer guidelines are followed.

To ensure proper installation and prevent a void of warranty, the installation manual and the project specific documentation must be followed. TerraGen must also be provided with sufficient digital site inspection documentation outlined in 'Appendix G' with sufficient accompanying photo evidence and have record of the annual maintenance activities outlined in this manual.

In unique or custom cases where alternative components or design is required, the project specific documentation will supersede the installation manual where there is insufficient or conflicting information.

2. Material Receiving

A detailed bill of lading will be sent with the shipment of racking. The receiver must confirm that all parts received are according to the detailed Bill of Lading and Packing Slip. Any damage must be noted on the bill of lading upon receipt. Any discrepancies must be reported within 2 business days. Otherwise, all claims will be invalid. If there are any damaged parts or rails, please provide a picture as well as documenting it on the Bill of Lading.

3. Tools

Tools:

1. Drill with torque limiter OR torque wrench
2. 13mm deep socket
3. 13mm combination wrench

NOTE: Accessories may require additional tools

Torque Settings Required:

8 ft-lbs (11 N-m): Tilt Assembly, base rail splice

12 ft-lbs (16 N-m): Cross adapter, end clamp, mid clamp

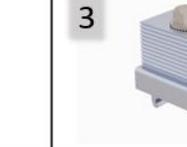
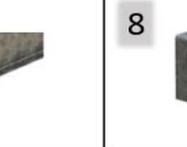
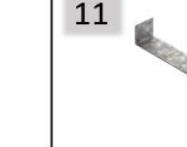
Miscellaneous:

1. Onsite cutting availability
2. Measuring tape
3. Paint marker (for torque marking)
4. String and/or spray paint (for alignment)

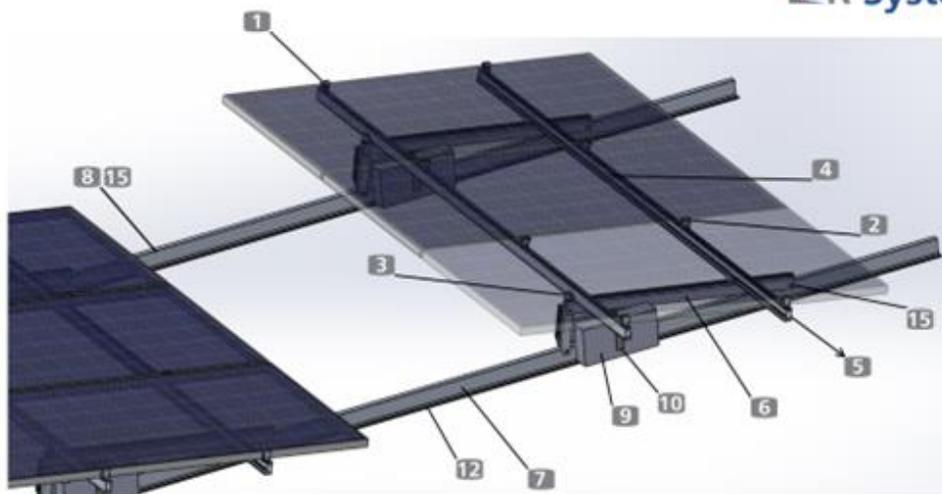
- **Use of impact tools when installing clamps and hardware will cause galling (seizing of SS hardware). TerraGen will not free issue components damaged from use of impact tools.**
 - **All fasteners must be torque marked after applying the required torque.**



4. System Components

1 	2 	3 	4 
End Clamp	Mid Clamp w/Bonding Washer	Cross Adapter	Top Rail
5 	6 	7 	8 
Splice 1966 (Bonding Integrated)	Tilt Assembly (Pre-Assembled)	Base Rail	Base Rail Splice
9 	10 	11 	12 
Ballast Block (locally procured upon request)	Ballast Clamp	Stack Clip	Ballast Tray
13 	14 	15 	
Rubber Pad	T-Bolt (M8) & Nut (upon request for MLPE)	Hex Bolt (M8x50) & Nut	

TGR System



5. Annual Maintenance Activities

The activities described below for the maintenance of the solar racking provided by TerraGen must be performed a minimum of every 12 months from the date of installation up until the system has been decommissioned. Records with images of the inspection must be recorded and kept.

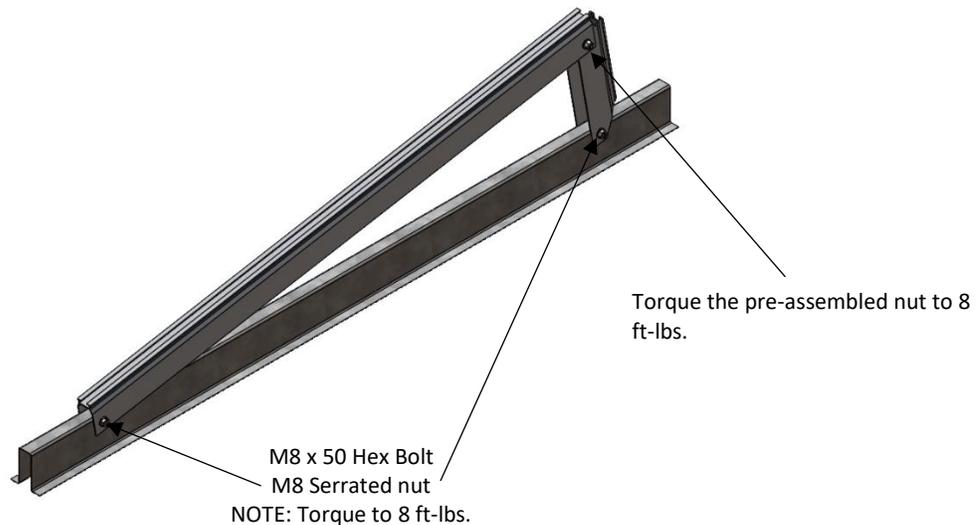
- Perform a visual inspection of the system to check all components for any signs of defect. Any components showing signs of damage that compromise safety shall be replaced immediately.
 - Check for any deformation, penetrating corrosion, or other noticeable defects in the components.
 - Inspect roofing condition around the contact points with the roof and that the system has not moved over time. Ensure appropriate roof protection is still secured appropriately in place.
 - Ballast (when applicable) is secured as intended with no cracks or degradation.
 - Modules are seated correctly and secured.
- Check all hardware for specified torque or torque marks. Any loose components or fasteners shall be re-tightened in accordance with the installation instructions.

6. Installation of System

6.1 Prep Work & Pre-assembly

6.1.1 Tilt Assembly Installation

Assemble the tilt assemblies onto the base rails using the M8x50 mm bolt through the pre-punched holes and securing with the M8 serrated nut. This hardware is to be torqued to 8 ft-lbs.



A is where tilt assemblies are placed. B is space between tilt assemblies. $S + N = B$ in most cases. N and S represent the amount of base rail left over at the North end and South end, respectively.



Base Rail Side View

6.1.2 Cutting Rails

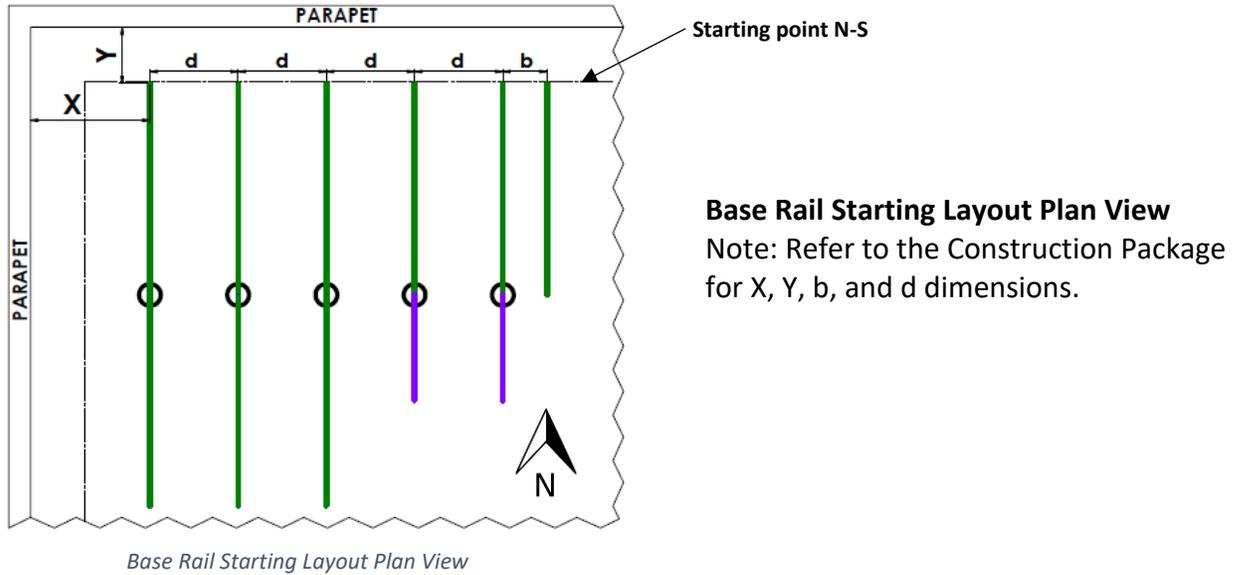
Please refer to the Construction Package for the cuts required for the project, it is advantageous to set up a cutting station to prep all of these before installation.

6.2 Base Rail Installation

6.2.1 Base Rail Layout

Locate the starting point for the first base rail according to the Construction Package. The remainder of the base rails can be located in reference to the starting base rail with

proper center to center spacing from the Construction Package, by measuring or using a spacing jig. No additional measurements are absolutely required to align the front and back base rails, though a string or laser line can be helpful.



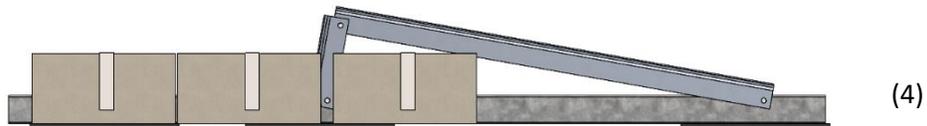
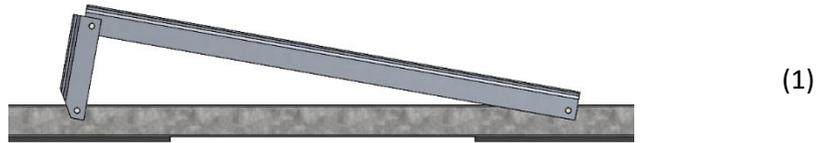
6.2.2 Rubber Pad Installation

Install rubber pads underneath the base rail in the locations shown. Remove backing paper to expose adhesive side and stick to the base rail. Ensure all contact points with the roof are covered.



Rubber Pad Installation Locations

Rubber pad to be placed under each tilt assembly hole location (1), base rail splice location (2), continuous rail ends (3), and ballast in the interrow (4).



Roof warranty holder should be contacted to ensure compatibility with the roof membrane and ensure the roof warranty is maintained, if applicable.

If any part of the base rail is contacting the roof in locations without the rubber pad, shift the rubber pad accordingly to protect contact points ensuring that a minimum of 3" has been left for drainage.

Ensure that all edges of the base rail are protected by the rubber pad.

Alternative rubber coverage can be accommodated at customer's request.

6.2.3 Base Rail Splicing

To connect adjacent base rails, four M8x50mm bolts are to be used to fasten the base rail splice over the 2 base rails. Tighten nuts in this order: 1,4,2,3 to ensure even loads.



Roof Slope Changes

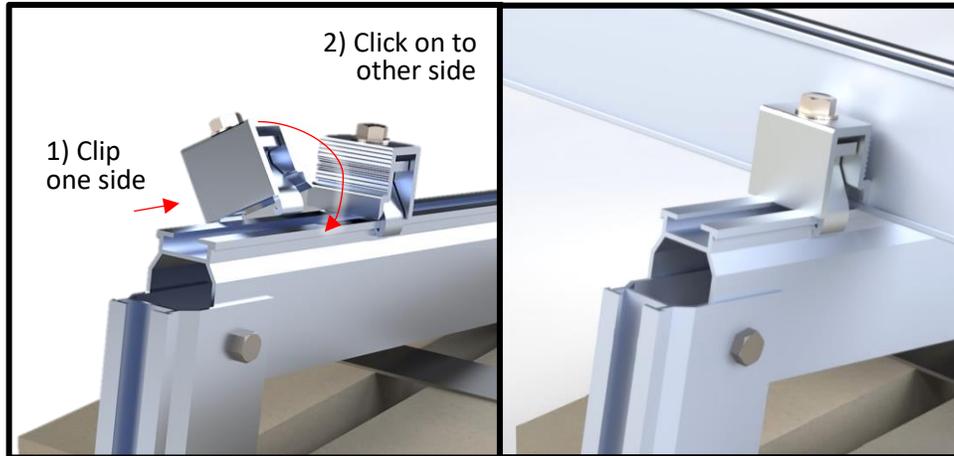
If minor roof slopes cannot be accommodated with four bolts, the method shown below can be used. This method below adds eight #10-3/4" self tapping screws.



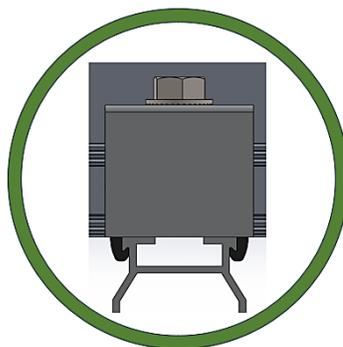
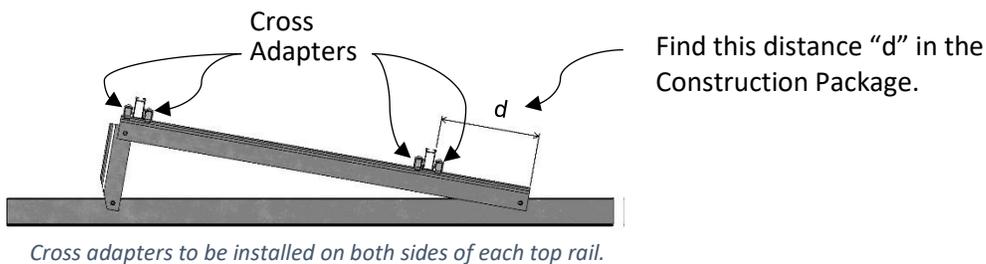
6.3 Top Rail Installation

6.3.1 Cross Adapter Setup

Use cross adapters to secure the top rails to the tilt assemblies. Click the cross adapter onto the tilt assembly to attach a top rail. Once both cross adapters are installed on both sides of the top rail, torque the bolt to 12 ft-lbs. Two cross adapters are required at each top rail connection. Refer to the figure below for a visual of the installation method.



The figure below illustrates how to determine the location of the cross adapters.



CORRECT - BOTH SIDES ENGAGED

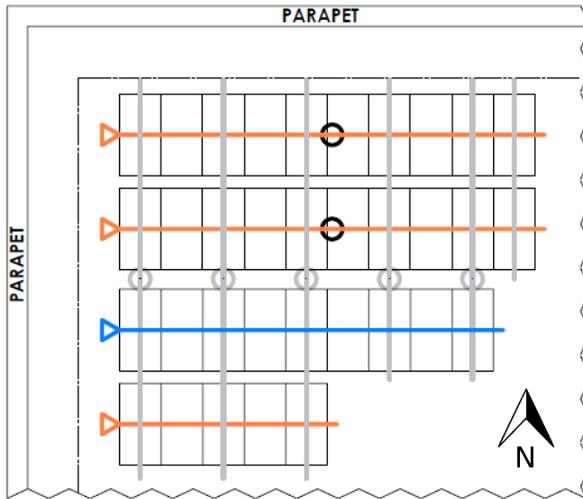


INCORRECT - NOT ENGAGED / ANGLED

 MOVE CLAMP SIDE TO SIDE TO ENSURE CLAMP CLICKS IN PLACE

6.3.2 Top Rail Layout

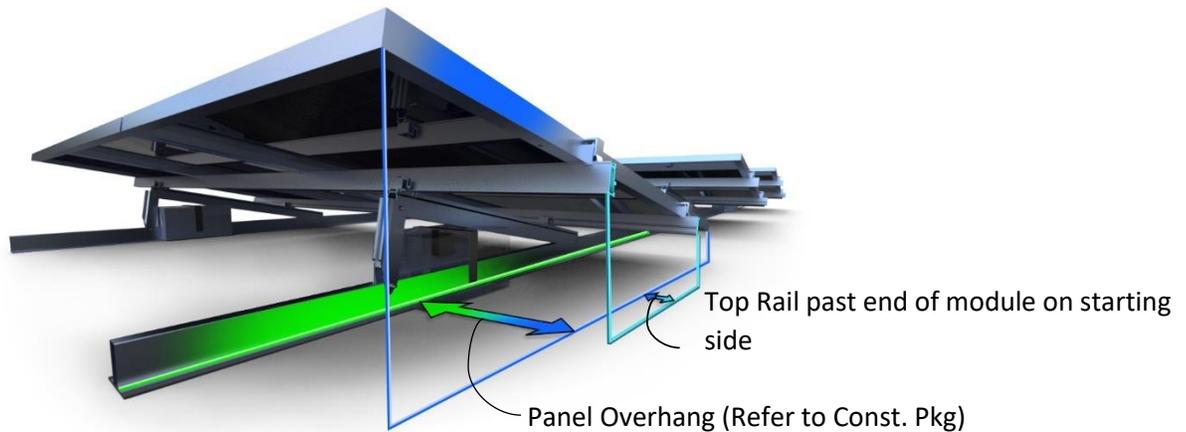
Top rails should be installed in the locations specified by the top rail layout plan. The layout plan can be found in the Construction Package. Please refer to it for top rail cut lengths and positions.



Top Rail Starting Layout Plan

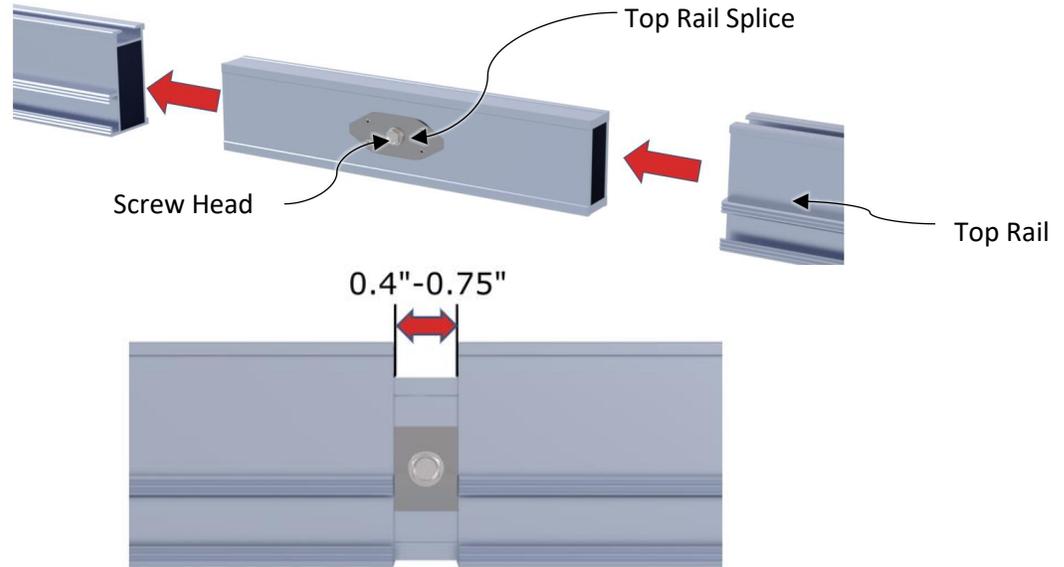


The maximum overhang amount is also specified in the construction package and it is measured from the edge of the mounted panel to the base rail. A minimum of 2" of top rail is required past the end of the module on the starting side.



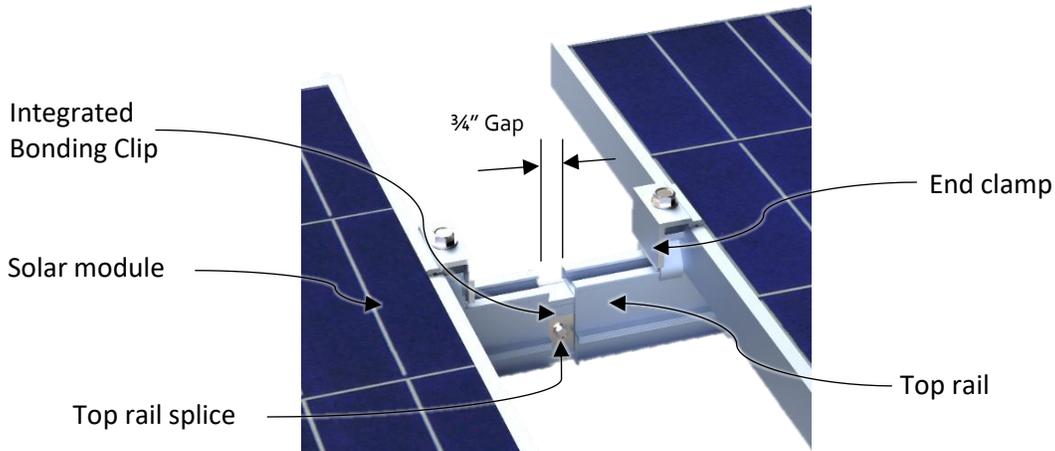
6.3.3 Top Rail Splicing

When required, the top rails get spliced together with a bonding integrated splice bar. Ensure that the top rail is stopped by screw head and that the bonding clip is engaged with the aluminum from both rails. Where thermal breaks are required, a $\frac{3}{4}$ " gap must be maintained between the ends of the top rails.



6.3.4 Top Rail Thermal Breaks

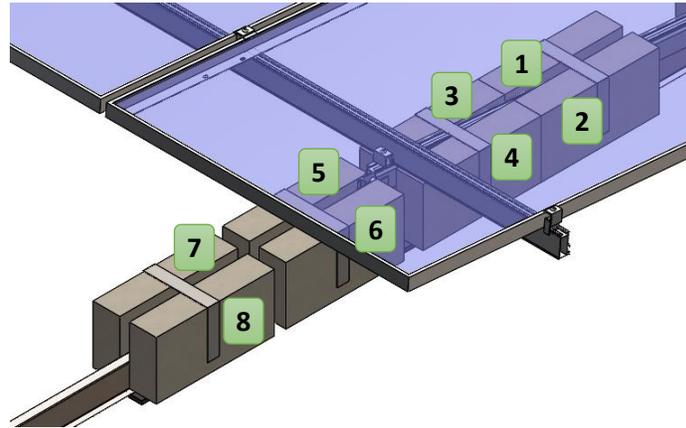
In the case of extended rows where a thermal break is required (refer to Construction Package), a module break is required separated by end clamps and a splice.



Due to undulations on the roof surface, the angle between the thermal break and the rails may be too large (>2 deg) to allow sliding of the rails on the splice. If this occurs, then the splices on either side of the rail which are not thermal breaks should be Tek screwed to lock them in place.

6.4 Ballast Installation

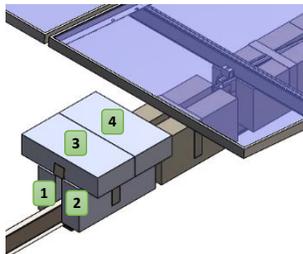
Secure blocks with the provided ballast clamp in the appropriate locations according to the ballast plan on the Construction Package. Please refer to the ballast block drawing for further information located in the Construction Package.



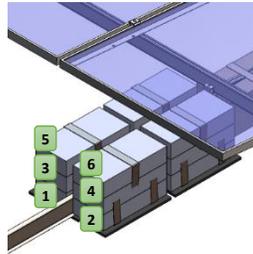
TGR Assembly with Ballast

Ballast Alternatives

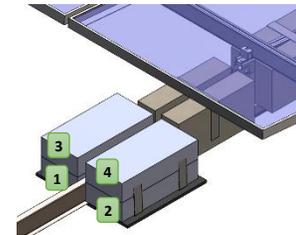
If a ballast stack clip configuration is required (refer to construction package), install 2 additional blocks on top using the 'stack clip' as shown below. If ballast trays are required, utilize the configurations below corresponding to the ballast plan of the construction package.



TGR Assembly with Stack Clip



TGR Assembly with 6 Block Ballast Tray



TGR Assembly with 4 Block Ballast Tray

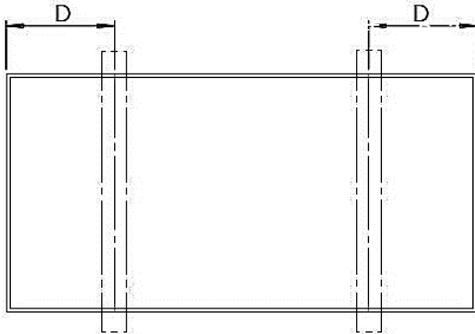
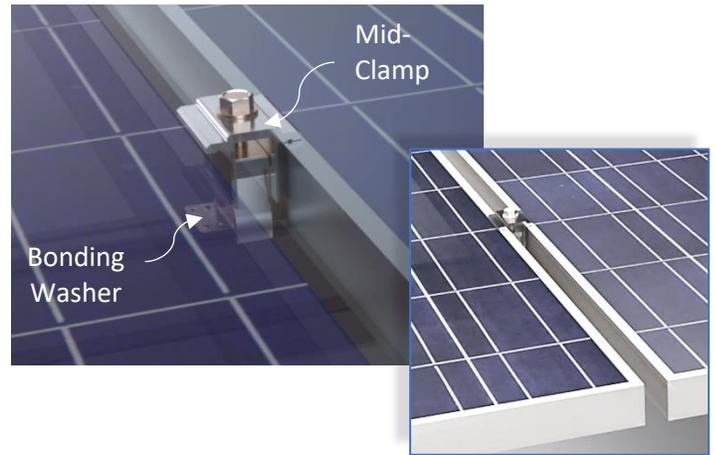
6.5 Home Run Wiring

After top rail installation is complete, this would be the best time to run all PV cable and home runs as this allows the installer to have free range of access to the racking for securing the PV cable.

6.6 Module Installation

Install the modules by first clicking the end clamps onto the end of the top rails. Adjust the module to the proper position and torque the end clamp bolt between 12 and 14 ft-lbs, **only exceeding 12 ft-lbs if necessary to ensure clamp sits flat on module frame.**

Next, click the mid clamps and bonding washer onto the top rail (refer to *Appendix B*). Slide the mid-clamp in tight to the module making sure that the tab of the bonding washer is placed under the module frame. Once the next module is placed properly, the mid clamp can then be secured, and the bolt torqued to 12 ft-lbs.



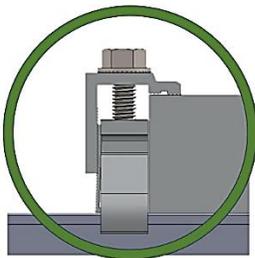
End clamp



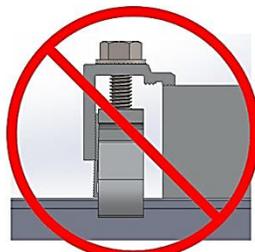
Mid-clamp w/
Bonding washer



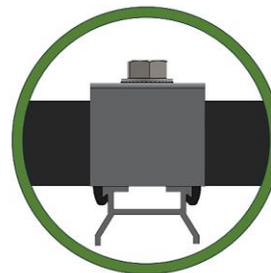
WEEB CCR2
(Upon Request)



CORRECT - CLAMP AGAINST FRAME



INCORRECT - LARGE GAP BETWEEN
CLAMP AND FRAME



CORRECT - BOTH SIDES ENGAGED



INCORRECT - NOT ENGAGED / ANGLED



PRESS CLAMP TO FRAME PRIOR TO TORQUING



MOVE CLAMP SIDE TO SIDE TO ENSURE CLAMP CLICKS IN PLACE

See construction package for details on clamp zones. TerraGen makes every attempt to ensure that the module clamping zones of the module manufacturer are met. However, ultimately it is the responsibility of the customer to verify that the module warranty will be maintained.

Appendix A: Ballast Requirements

The TGR Ballasted System has been designed utilizing concrete blocks that range from 30-33 lbs. Provided components are designed to these dimensions, and any discrepancy with the block size will alter the function of these components. While these standard sizes are recommended for use with the TGR system, custom sizes can be accommodated upon review and approval by TerraGen. Refer to the project specific construction package for ballast weight, quantity, and placement.

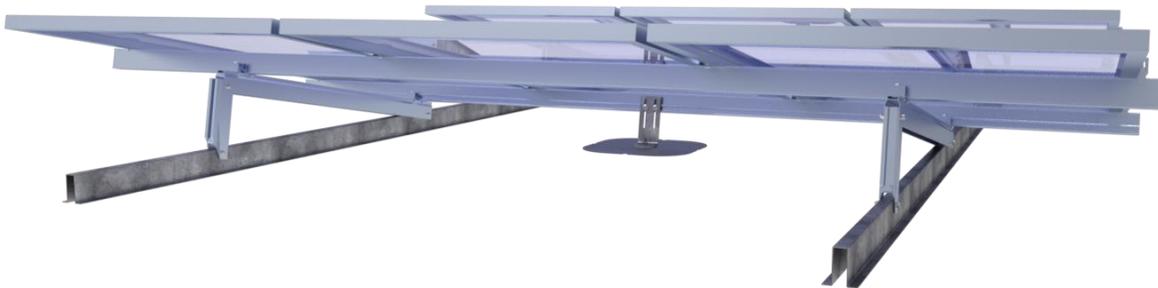
Notes:

1. **RANGE OF DIMENSIONS (D x H x W):** 15 3/8" x 7 1/2" x 3 1/2" to 15 9/16" x 7 1/2" x 3 5/8"
2. **ALLOWABLE WEIGHT VARIANCE:** ± 0.32 kg (0.71 lbs)
3. Dimensions may slightly vary depending on location of blocks



Mechanical Attachments

An alternative method of uplift/lateral resistance is the use of roof attachments. TerraGen's system is compatible with various attachment options. One example of an attachment is shown below. Refer to the project specific construction package for details if attachments are required.



Appendix B: Bonding & Grounding

The system has been evaluated/certified for Grounding/Bonding, and conforms to UL 2703. Refer to 'Module Listings' document for modules that have been certified to LTR AE-001-2012 and UL 2703.

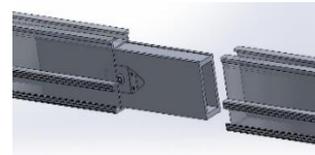
Connection 1: Module to Top Rail

Mid-clamps with bonding washers bond rails to module frames with teeth piercing the anodized surface of the module.



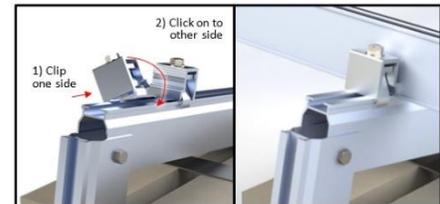
Connection 2: Top Rail to Top Rail

In cases where two or more rails may need to be spliced together, top rails are spliced through a sliding splice which consists of a bonding clip that pierces the surface of the aluminum rails.



Connection 3: Top Rail to Tilt Assembly

Top rails are connected to tilt assemblies using cross adapters.



Connection 4: Tilt Assembly to Base Rail

Tilt assemblies connect onto the base rails using the M8 - 50 mm bolt through the pre-drilled holes and secured with the M8 serrated nut.



Connection 5: Base Rail to Base Rail

Four (4) M8 - 50mm bolts fasten through the pre-drilled holes of the base rail splice over 2 flush base rails and fasten with the M8 Serrated nut.



Connection 6: Grounding Each Array

IlSCO SGB-4 or other UL 467 listed Grounding Device (supplied by others) is used to ground the system. Provided the previously mentioned connections all apply; each individual array only needs to be grounded once (though 2 locations are suggested). Location for grounding device is often the back leg of the tilt assemblies or the excess end of a top rail.

Appendix C: Installation Efficiencies

Pre-Assembly of Tilt Assemblies on Base Rails

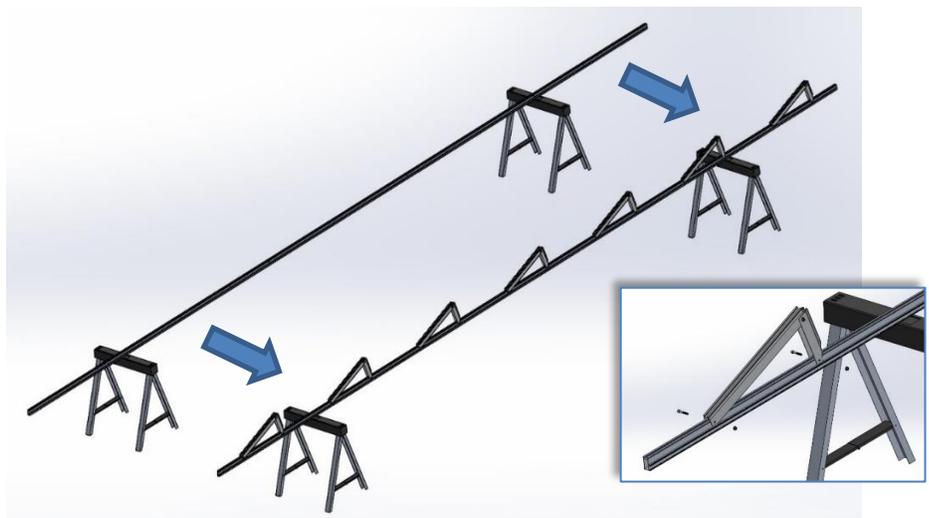
If a holding rack is available, such as the one shown in the photo below, you may choose to use this method to speed up the assembly process.



Telescopic Handler hoisting a holding rack with assembled base rails.

Prior to hoisting the skid of tilt assemblies and the bundle of bottom rails to the roof of your building, take time to pre-assemble the tilt assemblies onto the bottom rail while still on the ground. Using sawhorses to hold the work piece at waist height, cut all necessary lengths. Refer to your Construction Package for lengths of base rails.

Once cut, place tilt assemblies onto the entire length, lining them up to the holes. Use the M8 bolt and serrated nut to fasten the tilt assembly in place. Torque to 8 ft-lbs. Place on holding rack. Ensure that the bundle is adequately secured to the holding rack for hoisting to the roof.





Appendix D: Wire Management Options

	
<p>PHOTO #1: East West rails can be used to secure PV wire. In this image, the installer has used PVC straps secure on the rail to support the PV wire.</p>	<p>PHOTO #2: Another option for securing the PV wire to the east west rails is the optional wire management clips that TerraGen offers.</p>
	
<p>PHOTO #3: PV wire management using the optional wire management clips on the solar panel.</p>	<p>PHOTO #4: TGR base rails, (the north south rails) can be used to secure wires requiring management from row to row. We permit installers to secure wire management components to our base rail. In this case the installer used PVC conduit.</p>
	
<p>PHOTO #5: Row to row DC wiring can be pulled through PVC conduit attached to the base rail and split loom wire protection.</p>	<p>PHOTO #6: TGR base rails can be used to support cable tray for wire support running from West to East.</p>

Appendix E: MLPE Mounting

T-Bolt assembly is available upon request from TerraGen to mount MLPE (microinverter or optimizer) into the channel of TerraGen rails. Ensure that guidelines from the MLPE installation manual are followed.

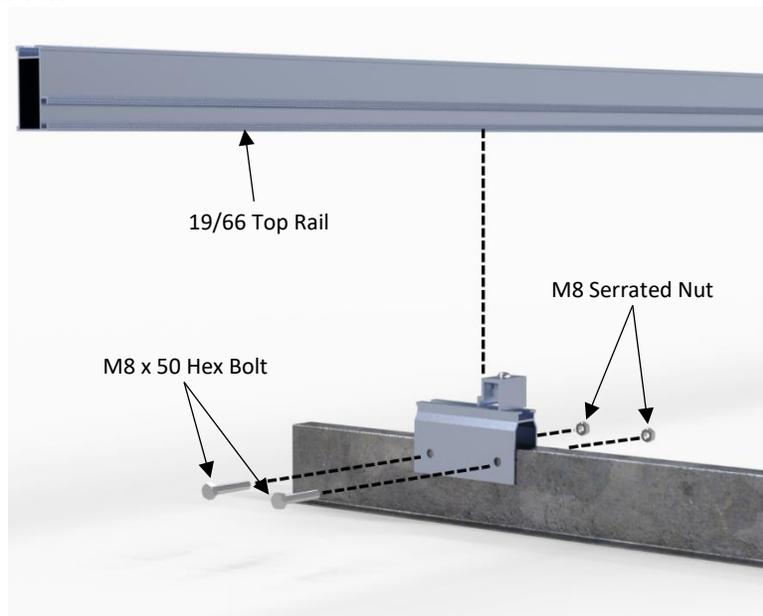


Appendix F: UL 2703 Fire Classification

The system has been evaluated/certified for Fire Rating, and has a UL 2703 Fire Class A rating for low slope roofs with Type I, Type II, and Type 29 modules with the addition of the top rail on the Northern perimeter of each array. The system will perform as expected provided it is installed over a fire-resistant roof covering rated for the application.



Fire Shield Installation





Appendix G: Site Inspection Report

Site Inspection Checklist

Purpose

The purpose of this checklist is to provide assurances that items highlighted below have been installed in accordance with the supporting documents provided. It is expected that all details from the supporting documentation have been followed and checked in every location, though photos provided in some cases only need to provide examples of such.

TerraGen will review the information provided and offer an opinion as to whether the work is generally complete and in conformance with the drawings and specifications. Any issues or deficiencies that are addressed must be corrected with full photo evidence.

Upon completion, TerraGen will issue a letter stating that according to the information provided, it is our opinion that the work is generally complete and in conformance with the drawings and specifications.

Note: The purpose of this letter is not to imply that TerraGen has completed a full inspection of the installed system.

Checklist:

Date:	Company:
Project Title:	Site Location:

I, _____, the supervisor of the site inspection, confirm that the checklist below has been completed accurately.

Signature:

Critical items to monitor, review and photo/video capture throughout the installation include but are not limited to:

- Rubber Pads have been placed under the racking covering all contact areas with the roof with sufficient gaps for drainage.
- Ballast has been installed as per the stamped drawing set provided by TerraGen Solar.
 - Provide Picture/Video evidence showing complete ballast layout for Array(s) prior to module install.
- Cross Adapters have been installed according to the construction package / installation manual. *Perform & document before module installation
 - 2 cross adapters at every connection.
 - 100% visual inspection has been performed for torque marks and proper engagement with the top rail.
 - A 2% spot check for correct torque values has been performed.
 - Provide sample images/videos of correct install.
- Module clamps have been installed according to the construction package / installation manual.
 - All module clamp legs are fully engaged with top rail grooves.
 - 100% visual inspection has been performed for torque marks and proper engagement with the top rail.
 - A 2% spot check for correct torque values has been performed.
 - Provide images/videos of correct install.
- Base rail spacing and module overhang from the construction package have not been exceeded.
 - Provide images of examples array(s) from the north side.
- Thermal Breaks have been installed correctly.
 - Provide images/videos of thermal breaks.
- Base Rail & Top rail splice have been installed correctly.
 - Provide images/videos of correct install.
- Provide general images of the project that show completion.

Other Comments:
