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Installer Responsibility

The installer is solely responsible to:
- Comply with all applicable building and electrical codes
- Meet municipal, utility, and inspector requirements
- Ensure installation methods and procedures meet all applicable OSHA safety standards
- Confirm all building structural members and related connections can withstand all forces resulting from the EcoX installation
- Maintain waterproof integrity of all existing roofing materials
- Verify all design criteria are correct and appropriate for the application and specific site
- Follow all manufacturer’s specifications, recommendations, and manuals
- Check that only Ecolibrium Solar approved materials are utilized during EcoX installation
- Guarantee array installation is completed by qualified and competent personnel
- Verify all equipment and materials are appropriate for application and site conditions
- Establish that anchoring devices, including lag screws, have adequate pullout strength and shear capacities as installed
- Determine that PV module is approved for use with EcoX and is capable of withstanding the project specific conditions.

Warnings & Safety

Both electrical and roofing knowledge is required to correctly and safely install a solar photovoltaic system. Only qualified and certified installation professionals should install EcoX. Failure to follow the methods and procedures outlined in this guide may result in injury and/or damage to property. Carefully read this guide before starting any work. Store a copy of this guide on the job site at all times and contact Ecolibrium Solar with any installation questions related to EcoX.

Please note the following warnings when installing EcoX:
- EcoX Bonding Clip may have sharp edges
- EcoX components fit together tightly and could cause pinch injuries
- EcoX components may be hot to the touch if left in the sun.

Please follow the safety requirements below when installing EcoX:
- Always keep children and unauthorized people away from work areas
- Always wear required OSHA approved Personal Protective Equipment (PPE)
- Always use insulated tools when working with or near electrical systems
- Always provide OSHA approved fall protection for all installation personnel
- Never wear jewelry during mechanical and electrical installation work
- Never work in rain, snow or extremely windy conditions
- Never leave a module unsupported or unsecured on the roof
- Never install broken photovoltaic modules
- Never use photovoltaic modules as a work surface
EcoX General Application Notes

System Design and Span Requirements: EcoX is designed to flush-mount photovoltaic modules on pitched roofs as described in this guide. The span between attachment locations depends on the module, the site conditions, and the system layout.

Site Specific System Design: The EcoX Estimator is a powerful system design tool. The user inputs all site conditions and can layout multiple roof surfaces. The EcoX Estimator outputs a site specific design package with engineering specs and bill of materials. Visit the EcoX Estimator at http://ecox-estimator.ecolibriumsolar.com to layout your array and instantly obtain attachment spacing, bill of materials, and engineering analysis.

Roof Type: EcoX is designed to mount photovoltaic modules to a range of roof surfaces, including:
- Asphalt or composite shingles
- Concrete or clay tiles (see Addendum)
- Membrane roof

Metal roofs are permitted as long as the method of bonding and grounding the metal roof is approved by AHJ. Contact Ecolibrium Solar if your project’s roof surface type is metal, or not listed above.

Wind Zone: EcoX is designed to mount photovoltaic modules on pitched roof surfaces in areas with extreme wind conditions. Please contact Ecolibrium Solar if your project’s wind speed exceeds the zone allowable in the EcoX Estimator.

Roof Height: EcoX is designed to mount photovoltaic modules on pitched roof surfaces with a mean roof height up to 60 feet. Please contact Ecolibrium Solar if your project’s mean roof height exceeds 60 feet.

Roof Pitch: EcoX is designed to mount photovoltaic modules on roof surfaces between 0 and 90 degrees from horizontal.

Roof Zones: EcoX is designed to mount photovoltaic modules on pitched roof surfaces in all roof zones with attachment spacing as prescribed in the EcoX Estimator.

Roof Orientation: Throughout this manual, “downhill” is used to reference the direction of the lower or leading edge of the array, and “uphill” is used to reference the direction of the trailing or back edge of the array.

EcoX Certifications

Approved Modules: This racking system may be used to ground and/or mount a PV module complying with UL 1703 only when the specific module has been evaluated for grounding and/or mounting in compliance with the included instructions. Specific modules included in EcoX certifications are documented in Appendix D at the end of this install guide.

Module Types: EcoX is certified to be installed with standard framed 60 cell modules according to the approved module list.

Mechanical Loading: EcoX is certified to UL2703 for mechanical loading. Tested modules are listed in Appendix D. Span requirements for a given jobsite can be determined using the EcoX Estimator design tool: http://ecox-estimator.ecolibriumsolar.com.

Fire Testing: EcoX is certified to UL2703/1703 Fire Resistance Standard with the following requirements:
- Instructions in this guide must be followed.
- The EcoX system must be mounted over a fire resistant roof covering rated for the application.
- Modules may be installed in landscape or portrait.
- The EcoX fire rating is valid with or without a skirt.
- All height settings of EcoX product are valid, up to highest setting (corresponds to 4 ¼” from roof surface to lower edge of module frame).

For pitches greater than 2:12 (9.46 degrees):
- EcoX is certified to Class A with Type 1 and 2 modules.
- Junction box must be mounted away from the roof downhill edge.

For pitches less than 2:12 (9.46 degrees), aka “flat” or “low-slope” roofs:
- EcoX is certified to Class A with Type 1 modules.
- Junction box can be mounted at any location.

Grounding and Bonding: EcoX is certified to UL 2703 for grounding and bonding. The grounding and bonding test evaluates EcoX as a system with approved modules. When installed per the requirements outlined in this installation guide, EcoX with approved modules are rated as a system to create a continuous bonded structure.

Installation Requirements: This install guide officially documents the components used and proper methods for an EcoX installation. Bonding elements are incorporated into EcoX components. As the system is built on the roof, components and modules are bonded together. Specific steps to ensure a bonded system are described through the installation guide. It is the installer’s responsibility to ensure that the system is safely and properly installed, and that the system is bonded back to a final ground point. There are no specific array size limitations due to the flexible and expandable design of EcoX Universal.

UL2703 System Documentation: To document UL 2703 system rating, a label is factory-applied to the end of each skirt. For Skirt-Free configurations, apply one UL 2703 label on each sub-array. Follow the instructions included along with UL 2703 labels in every box of End Couplings. Below is an example of the label:

The Date Code ABCYZZ shown above will appear on production parts, letters defined as follows:

ABC shall be an acronym for identifying the source factory.
Y shall be the Quarter of the year (i.e. 1, 2, 3, 4) of manufacture.
ZZ shall be the last 2 digits of the year of manufacture.
# Revision History - Install Guide

<table>
<thead>
<tr>
<th>Revision</th>
<th>Description of Changes</th>
<th>Date</th>
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<tr>
<td>1.0</td>
<td>Initial Release</td>
<td>2017-October-10</td>
</tr>
<tr>
<td>1.1</td>
<td>Updated Appendix D</td>
<td>2017-November-29</td>
</tr>
<tr>
<td>1.2</td>
<td>Updated Appendix D</td>
<td>2018-January-24</td>
</tr>
<tr>
<td>1.3</td>
<td>Updated Appendix D</td>
<td>2018-April-12</td>
</tr>
<tr>
<td>1.4</td>
<td>Added Modules to Appendix D</td>
<td>2018-July-18</td>
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<tr>
<td>1.5</td>
<td>Update UL 2703 PTL Certification Label Add note in General Application Notes and Appendix F for installer to apply label on Skirt-Free configurations.</td>
<td>2020-January-24</td>
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Added SunPower and Panasonic Modules to Appendix D
EcoX Universal Components

**Attachment Kit**
- 5/16" Lag Screw with Sealing Washer
- Dovetail Engagements (mates to Glider)
- Flashing

**Clamp Assembly**
- Upper Clamp
- Lower Clamp (tongue supports downhill edge of Module)
- Serrated Strut Bolt
- Bonding Clip (not visible)
- Glider
- Dovetail Engagement (mates to Spacer)
- Strut Bolt and Strut Nut secure Clamp Assembly to Base and Modules to Clamp Assembly.

**Coupling Assembly**
- Alignment Indicators
- Upper Clamp
- Lower Clamp (tongue supports downhill edge of Modules)
- Serrated Hex Bolts
- Bonding Clip (not visible)

**Skirts & Spacers**
- Skirts are used on the first downhill row to enhance the appearance along the edge of the array.
- Spacers (one per Clamp, two per Coupling) position Skirt to accommodate module frame thickness. Spacers are available in six Module thicknesses ranging from 32mm through 46mm.
- Vertical Tab Engages Spacers securing Skirt to Clamp Assemblies and Couplings.
- Skirts are factory cut to length to match specific Modules.

See Appendix G for skirt-less installation details.
Power Accessory Bracket

- Mounts a micro-inverter or power optimizer to the Module.
  - The serrated teeth ensure a secure connection to the module.
  - The Power Accessory Bracket bonds the micro inverter or power optimizer to the Module.
  - Torque Spec: 14 ft-lbs

Row to Row Bonding Clip

- Bonds each row of modules to the next.
  - Bonding Clip is added to the uphill side of one clamp per row.
  - For systems using the skirt, Bonding Clip bonds skirt to first row of Modules.

Junction Box Bracket

- Mounts to the Base, and acts as a support for a Junction Box.
  - Can be installed to any base.
  - Can be installed before or after modules are installed.
  - Torque Spec: 10 ft-lbs

End Clamp

- Mounts to the base on the downhill row, and may be used in place of the Skirt for a Skirt-Free installation.
  - Dovetail Engagement to base for height and uphill/downhill adjustment.
  - Upper End Clamp secures module.
  - Integrated bonding clip bonds module to clamp and Attachment Kit.
  - Torque Spec: 14 ft-lbs

End Coupling

- Connects two modules left to right.
  - End Couplings include indicator marks to set a ½” gap between Modules.
  - Factory installed Bonding Clips (two per End Coupling) bond modules left to right.
  - Torque Spec: 14 ft-lbs
The EcoX installation begins at the downhill edge of the roof and progresses uphill. Installation is sequential and requires minimal hand tools.

**Installation steps:**
1. Layout Array on rooftop.
2. Install Attachment Kits to rooftop.
3. Install Junction Box Bracket.
4. Install Clamp Assemblies and Spacers on downhill row.
5. Install Spacers and Skirts on Clamps in first downhill row.
6. Install Couplings and Spacers to Skirts.
7. Install Modules.
8. Install Clamps and Couplings on uphill side of Modules.
9. Level the row of Modules.
10. Repeat Module install on subsequent rows.
11. Install additional Bonding Clips at one end of each row to complete row to row bonding.

**Required Tools:**
- Tape Measure
- Chalk Line
- Hammer
- Drill with 3/16" Bit
- Flat Roofing Bar
- Impact Driver
- 1/2" Socket
- String Line
- Torque Wrench
- Chalk

---

Note: Rooftop and shingles not shown for clarity
1. Layout Array on Rooftop

1a. Mark the Four Corners of Array

Using chalk, layout the footprint of the array on the rooftop. Look for any obstructions on the rooftop that could prevent a complete and proper installation of the array.

1. Starting from the downhill edge, place a mark 2-1/2" up from the bottom edge of the downhill course of shingles.

2. Using the Module dimensions include the following:
   - Left/right include a 1/2" gap between Modules.
   - Uphill/downhill includes a 3/4" gap between Modules.

The following page continues this layout and illustrates a finished rooftop layout.

Knowing where the Modules intersect will identify potential interferences between Attachments and Couplers.

Most AHJ’s require a roof setback per their local fire code requirements. Make sure that the required setback is observed when marking the footprint of the array.
1. Snap left/right chalk lines.
2. Mark the attachment locations by locating the structural members of the roof. Refer to the EcoX Calculator for maximum allowable span and cantilever.

Ensure that attachment locations meet and do not exceed, the EcoX design specifications on allowable spans and cantilever distances.

When marking the attachment locations, make the downhill leg of the mark long enough to be visible from the downhill edge of the Flashing when the Flashing is in its installed position. This mark will accelerate the Flashing installation by quick alignment of the Flashing to the mark.

1b. Snapping Chalk Lines and Marking Attachment Locations

- Corners of Array
- Roof Structural Members
- Attachment Locations
- Make these marks extra long downhill. See icon.
- Cantilever
- Span
- Uphill

1. Layout Array on Rooftop (cont.)
What follows is basic information on wiring an EcoX array.

Warning: All wiring must be done in compliance with NEC and AHJ requirements.

It is advisable to prepare Modules on the ground before moving them to the rooftop. This can be done as penetrations are installed.

1. Finalize the junction box location and string diagram as soon as the array design is marked on the roof and confirmed.
2. Once the EcoX bases are installed use the Junction Box Bracket to mount the junction box.
3. Use the EcoX Power Accessory Bracket to attach Microinverters or Optimizers to the modules.
4. Prepare modules on the ground for easy wiring on the roof.

The maximum OCP rating is 20A when using an Enphase micro-inverter for grounding.

2. Prepare the Modules - Before moving them to rooftop

2a. Wire Management: Position Leads, install Clips

Arrange leads for easy access. Use a string map to determine the direction that + and – leads will face for each row.

Use the EcoX Power Accessory Bracket to attach Microinverters or Optimizers. See Appendix E for installation details.

Use wire management Clips to arrange wiring and keep away from roof top, and/or interfering with Clamps or Couplings.

Position and attach Microinverters or Optimizers. Remove their provided identification stickers and place them on the array map. Use a marker and label each unit for easy identification.

2. Prepare the Modules - Before moving them to rooftop
3. The Basics on Wire Management

3a. Suggested Routing and use of Clips

Image shows an example wire layout to illustrate typical wire management.
4. Install Attachments to Roof

4a. Proper positioning of Flashing to Shingles
- Incorrect: Do not allow Flashing to extend below the downhill edge of Shingle
- Flashing is aligned with downhill edge of Shingle

4b. Drill 3/16" pilot hole
- Drill 3/16" Pilot Hole
- Attachment Location
- Corner of Array

4c. Apply Caulk to Flashing
- Bottom Side of Flashing
- Horseshoe shaped Caulking
- Use roof compliant sealant.

Positioned Incorrectly
- Incorrect: Do not leave a gap between Shingles not completely covered by Flashing

Positioned Correctly
- Remove nails as needed for clearance
- Trim notch in shingle to clear Base
- 2-1/2" above downhill edge

Acceptable Position (when necessary)
- Position correctly positioned the Flashing will prevent water damage to roof from water seepage and/or freeze/thaw cycles.
- Best practice is to position the Flashing mounting hole 2-1/2" up from the bottom edge of the shingle course. This places the Flashing downhill edge flush with the edge of the shingle course it's mounted on.
- It is acceptable to shift a Flashing uphill on its shingle course and to trim the uphill shingle to clear the Base.
4. Install Attachments onto Roof (cont.)

4d. Place Flashing

- Slide Flashing under uphill course of Shingles
- Use Flat Roofing Bar to lift uphill Shingles
- Align with Pilot Hole/Chalk Line

If necessary, clearance trim the up-course Shingles to clear the Base. Line up the Flashing’s mounting hole to pre-drilled pilot hole and square the Flashing to the Shingles.

⚠️ The bottom or downslope edge of the Flashing must not extend beyond the course of Shingles that it’s attached to.

4e. Attach Base

- Lag Screw with Sealing Washer
- Base

Be sure to orient the Base as shown with its offset mounting hole directed uphill. On the Skirt row the Base can be rotated 180 degrees which helps hide the Base behind the Skirt (see examples below). Install the Base using the Lag Screw with its pre-installed Sealing Washer. Drive the Lag Screw into the roof structure securing the Base and Flashing to the roof top. Torque to 14 ft-lbs to ensure seal.

Torque to: 14 ft-lbs

Base Positioning - Skirt Row vs other Rows

- Uphill
- Base can be rotated 360 degrees to allow adjustability of Clamp position. Rotates around its offset mounting hole.
- Skirt row Base Position
  - It’s recommended to rotate the Base so its offset mounting hole is downhill. This helps hide the Base behind the Skirt.
- Standard Base Position
  - Offset mounting hole is uphill.
5. Install the Junction Box Bracket

5a. Attach Bracket to Base with Self Drilling Screws

The Junction Box Bracket is attached to the Base with Self Drilling Screws. Select one of the previously installed Bases in a location suitable for mounting the Junction Box and install the Bracket as shown.

Torque to: 10 ft-lbs

The Junction Box can be secured to the Bracket with Self Drilling Screws or by utilizing the Universal Mounting Slots along with appropriate attaching hardware.
6. Install the Clamp Assemblies (if installing Skirt-Less version skip to Appendix F)

6a. How to Set the Clamp Assembly Height via the Glider

Height settings are made by utilizing the 5-position dovetailed engagements of the Glider-to-Base. The image to the left shows three of these positions. 1" range of travel is possible in 1/4" increments. This equates to 1/8" variation from Glider to adjacent Glider to adjust and compensate for irregular or undulating roof tops.

Start by setting the Glider on the end-of-row Clamp Assemblies to their middle position and then adjust other Clamps along the row as needed to level the row.

6b. Install the Clamp Assemblies

Start in Middle Position

Align Dovetail Engagements and Slide onto Base

Long “Tongue” of Lower Clamp points uphill

Align north edge of Glider with marks (shown in red) provided on Base

Note: For clarity the Upper and Lower Clamps are shown transparent.
6. Install Clamp Assemblies (cont.)

6c. Engage Strut Nut with Base

Use an impact driver to tighten the Strut Bolt and engage the Strut Nut channels with the two flanges of the Base. Leave the Clamp open to accept the Module. The Leaf Spring provides pressure to keep the Strut Nut engaged and in-position while the installation continues. Further tightening will be done as the Modules are installed.

Note: For Skirt row Clamp installation only.

Do not over tighten the Clamps on the Skirt row. They need to be open enough to accept the Skirts. All non-Skirt row Clamps will be tightened as they are installed.

7. Level and Align Clamp Assemblies on Southern Row

7a. Run a E-W String Line

Position String on top groove of the two outermost left/right Clamp Assemblies. Align outermost left/right Gliders with Marks on Bases. Run String on uphill side of Clamp Assembly. A String Line is used to level and align Clamp Assemblies on the first downhill row only. The body of the Glider includes one “String Groove” specifically designed to assist with this process. Run and secure the String Line between the two outermost left/right Clamp Assemblies. Place String on the top String Grooves, pulling it taught and securing its ends.
7. Level and Align Clamp Assemblies (cont.)

7b. Level and Align to String Line

**Problem:**
Top Groove not aligned with String Line

**Solution:**
Raise Glider one Dovetail Engagement (1/4") to align Top Groove of Glider with String

**Height Adjustments**

**Problem:**
Gap too large between String Line and Glider

**Solution:**
Reduce gap by sliding Glider Toward String leaving a gap of 1/16" or less

**Uphill/Downhill Adjustments**
8. Install Skirts on Downhill Row

8a. Overview - Module Sizes, Spacers & Skirt

- Use the Spacer that correlates to the Module thickness. Spacer size is indicated by the number of marks on its top surface.

- Marks on Spacer: 4 marks = 38mm Module 1-5/8" Thick

- Spacers are module-specific, with the corresponding Module size shown by marks on the top of the spacer.

- One Universal Skirt is used with the range of Module thicknesses.

- When the correct Spacer is installed with the Skirt, the Upper Clamp is positioned to match the Module thickness.

- Universal Skirts are installed along the first row, held in place by Clamps with a Spacer to set the position. Skirts are joined end-to-end by Couplings.

8b. Install the Spacers and Skirt

- Install Spacer by aligning and mating the dovetail engagements. Center the Spacer over the Clamp.

- Tilt and roll the Skirt Tab into the slot between the Spacer and the Lower Clamp.

- Tighten Strut Bolts enough to hold Skirt in position - leave Clamps open to accept Modules.

- Align the left/right position of the Skirt with the outer edge of the array. Torque Clamps to 14 ft-lbs. Check to ensure north side of Clamp is positioned to accept Module.

- Torque to: 14 ft-lbs

EcoX Universal Installation Guide, Rev 1.5
8. Install Skirts on Downhill Row (cont.)

8c. Install Coupling and adjacent Skirt

1. Install two Spacers by aligning and mating their dovetail engagements. Place them at opposite ends of Coupling, flush to the ends.

2. Slide Coupling onto installed Skirt, positioning Skirt Tab into slot between Spacer and Coupling.

3. Tighten one Bolt to hold Coupling in place.

4. Slide next-in-line Skirt into Coupling, positioning Skirt Tab into slot between Spacer and Coupling.

5. Tighten second bolt and torque both Bolts to 14 ft-lbs.

As with Clamps, Couplings must be installed with appropriate Spacers - matching the specific Module thickness.

T Torque to: 14 ft-lbs

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8d. Left/Right Positioning of Coupling

**Left/Right positioning of Couplings is flexible.**

Couplings can be adjusted “off-center” of Skirt joint as needed to work around an Attachment or other roof obstacle. If Coupling must be moved off-center, utilize its alignment indicators as guides and offset Coupling no less than 1” minimum allowable overlap.

- **Centred Coupling**
- **Offset Coupling**

**Obstacle:** Attachment requires Coupling to be offset from center. Offset is acceptable but within limits.

**Attention:**
- Do not offset Coupling less than minimum allowable 1” overlap. Doing so will cut the electrical bond of the array and reduce structural integrity.
8. Install Skirts on Downhill Row (cont.)

8e. Working around Obstacles

<table>
<thead>
<tr>
<th>Problem: Clamp Assembly prevents proper positioning of Coupling</th>
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<tbody>
<tr>
<td>Coupling cannot be properly positioned, it needs to shift about 1/2&quot; to the left</td>
</tr>
<tr>
<td>Rotated Base allows movement of Clamp Assembly</td>
</tr>
<tr>
<td>Coupling can now shift into proper position</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solution: Rotate the Base and reposition the Clamp Assembly.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: If this solution does not work see Appendix A</td>
</tr>
</tbody>
</table>

The example at far left demonstrates how a Clamp Assembly might become an obstacle to the Coupling. If a Clamp Assembly obstructs the proper positioning, the Clamp Assembly position can be altered by simply rotating its Base via the Lag Screw. First, loosen the Lag Screw securing the Base to the roof, then rotate the Base and re-position the Clamp Assembly by sliding the Glider as needed in order to properly place the Clamp Assembly in relation to the Skirt. (See the second example at left)
9. Install Modules

9a. Pivot Modules into Clamps & Couplings

1. Hold the module on its uphill edge, and place its downhill edge onto the tongue of the Lower Clamps and Coupling of the Skirt Row.

2. Pivot its uphill edge downward toward the Base/Lower Clamps of the uphill row.

3. Rest the Module on the Base.

4. Be certain that the Module Frame has fully seated into/against the Clamps and Couplers of the Skirt Row.

Ensure that Module is fully seated in Clamp Assembly and Coupling.
9. Install Modules (cont.)

9b. Continue installing Modules across Skirt Row

Working across the Skirt row set the Modules in place while leaving a ½” gap between them. Set the gap by the alignment marks on the Skirt row Coupling(s) and aligning the Module frames to these marks. **Wiring**

As each row of Modules is installed, complete all wiring connections and verify that all wire management clips and wires are properly arranged and off the rooftop before proceeding to the next row of Modules.

Install home runs or trunk cable if necessary as each row of modules is installed.
9. Install Modules (cont.)

9c. Install the Uphill Clamps

- Slide Gliders to set Clamp Assemblies against the Module.
- Leave the Clamp Assembly loose while you position the remaining Clamps and install the Couplings.

9d. Install the Uphill Couplings

- Use Coupling alignment marks to center Coupling over the 1/2" gap.
- Coupling can be offset of center; the same procedures apply as identified in Step 9b Left/Right Positioning of Coupling.

- After the Coupling has been positioned tighten and torque to 14 ft-lbs.
- Torque to: 14 ft-lbs
9. Install Modules (cont.)

9e. Coupling alignment on Modules with Non-Metallic Corners

For Modules that are constructed with non-metallic corners, ensure the Bonding Clip in the Coupling is fully engaged with the metallic frame of the Module.

When setting the Couplings position on Modules with non-metallic corners, the Couplings left/right range of adjustability is reduced due to the non-metallic area of influence. This area of influence varies by Module make and therefore a close visual inspection must be done to ensure that the Bonding Clip has cleared these areas.

Note: For clarity the Couplings are shown transparent.
10. Level the Modules

Level Modules Row-by-Row

Problem:
This Module is lower than the others and needs to be elevated.

Solution:
Remove Glider and raise it one Dovetail Engagement. Evaluate for level and readjust if needed.

Leveling the Modules
As work progresses the Modules will need to be evaluated by eye and leveled row-by-row.

1. From the roof, visually evaluate the rows for a consistent level left to right, uphill, downhill and to the row below. Ideally, get an evaluation from someone on the ground as well.
2. If elevation adjustments are required, raise or lower the Glider positions (as needed) on their respective Bases to bring things into level.
3. After leveling, tighten the Clamps to 14 ft-lbs.

Clamps have been evaluated and rated for multiple use. Repeat Steps 9a through 9e for the remaining rows of Modules.

Torque to: 14 ft-lbs

Remember: Each dovetail engagement equals 1/4" elevation change
11. Grounding and Bonding

Adding uphill Bonding Clips Connect Row-to-Row

= Requires uphill Bonding Clip, in this example three Bonding Clips are required; one for each of the 3-rows
= Factory installed Bonding Clips

NOTE: Uphill Bonding Clips not required on the last uphill row of Clamps

Row to row bonding must be completed in one location at the end of every row. This must be done between the skirt and the first row of modules, and between every row of modules. The image at left shows the general location of row to row bonding within an array.

There are two options for row to row bonding:

Option 1 uses a bonding clip, added on the uphill side of any one clamp in each row.

Option 2 is any bonding jumper that is tested to UL2703 (see the following page for details).

On Skirt row, the Skirts create continuously bonded row left and right

Note: Although the uphill Bonding Clips are shown on the right end of the rows, they can be installed on either end of each row.
11. Grounding and Bonding (cont.)

Option 1: Use our Bonding Clips

**Module-to-Module**

Slide Row to Row Bonding clip onto uphill side of the Upper Clamp

**Skirt-to-Module**

Slide Row to Row Bonding clip onto uphill side of the Upper Clamp

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*EcoX Universal Installation Guide, Rev 1.5*
11. Grounding and Bonding (cont.)

Option 2: Use a Bonding Jumper: Module-to-Module

- Specialized bonding clips clip onto the underside flange of Module frame.
- Bonding Jumper bonds Module-to-Module.

Note: Bonding Jumpers are single-use only.

Option 2: Use a Bonding Jumper: Skirt-to-Module

- Bonding Jumper bonds Skirt-to-Module.

Note: Bonding Jumpers are single-use only.
Lugs and System Bonding

Install a single ground lug on each array in a visible location. Each ground lug is to be grounded to the common ground identified for this system in accordance with the National Electric Code, ANSI/NFPA 70.

- Wiley WEEB-LUG-6.7
- Ilsco Lay-in Lug GBL-4DBT
- Burndy CL50-1TN

Other UL 2703 listed ground lugs may also be suitable for this system if approved by the Authority Having Jurisdiction (AHJ).

Site specific plans are to identify grounding conductor size, type and temperature rating (if appropriate) as determined by a qualified engineer and approved by the AHJ.

The installer is responsible for ensuring the ground connection is properly installed per NEC requirements, including the gage of the EGC wire to be used.

The installer is also responsible for obtaining prior approval from the AHJ for the use of any grounding lug not listed above.

Ensure that bare copper wire is isolated from all aluminum components.

One ground lug per array must be installed. Ground lug can be installed on the module frame at the end of the array or on the EcoX Skirt or Base components as indicated in the drawing above and approved by the AHJ.

- Install approved grounding lug per lug manufacturer’s instructions. Instructions included in the following pages.
- Deburr any field-drilled holes.
- Wiley WEEB Lugs are “single use only”.

Module
(any location approved by the module manufacturer)

Base
(any flat, accessible surface with clearance for a torque wrench)

Skirt
(any flat, accessible surface with clearance for a torque wrench)
11. Grounding and Bonding (cont.)

The WEEB® Grounding Lug is installed using stainless steel mounting hardware. When the hardware is tightened, the WEEB® washer’s specialized teeth embed into anodized aluminum or any electrically conductive metal to establish a gas-tight electrical connection.

**WEEB® Grounding Lug**

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<th>ITEM #</th>
<th>LENGTH (in.)</th>
<th>WIDTH (in.)</th>
<th>MOUNTING HARDWARE</th>
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- Made of corrosion-resistant, line-plate copper
- No surface preparation on rail or module required
- Multiple configurations and connector options available
- One 14 AWG to 6 AWG or two 10 AWG, two 12 AWG

* Use listed by ETL to UL 486
* CSA Certified to C22.2 No. 41

11. Grounding and Bonding (cont.)

CL501TNMHWSGG1 and CL501DBKIT1 are packaged with required hardware as shown in stack “A”
CL501TNMHWSST and CL501DBKIT2 are packaged with required hardware as shown in stack “B”
CL501TN(BULK) and CL501TNMHWS are approved with hardware stack “A” or “B” as shown above.

*For Grounding and Bonding applications per UL467/CSA 22.2 No. 41 use hardware stack “A”.

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<th>Cat No.</th>
<th>Max OCPD (A)</th>
<th>Stack Type</th>
<th>Min Thk (in)</th>
<th>Max Thk (in)</th>
<th>Mtl</th>
<th>Surface Prep</th>
<th>Size</th>
<th>Tightening Torque (in-lbs)</th>
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Table 1: Mounting Surface Requirements

Important notes:
1. The NEC section 690.43 states, “Exposed non-current carrying metal parts of module frames, equipment, and conductor enclosures shall be grounded in accordance with 250.134 or 250.136 (A) regardless of voltage.”
2. For Proper Equipment Grounding Conductor (EGC) and Overcurrent Protection Device (OCPD) sizing, refer to NEC sections 250.66, 250.122 and 250.166.
11. Grounding and Bonding (cont.)

**INFORMATION SHEET**

GBL-4SS, GBL-4DBT, GBL-4DBTH, GBL-4DBT-14, and GBL-4DBTH-14 Ground Lugs

Installation Instructions for Photo Voltaic Applications

1) Install GBL-4SS, GBL-4DBT, GBL-4DBTH, GBL-4DBT-14 or GBL-4DBTH-14 ground lug per diagram (use #10-32 mounting hardware for GBL-4SS, GBL-4DBT or GBL-4DBTH; use 1/4-20 mounting hardware for GBL-4DBT-14 or GBL-4DBTH-14)

2) Apply a liberal amount of conductor (ILSCO DE-OX oxide inhibitor) on front and back side of module frame at mounting hole. Although not required, ILSCO strongly recommend the use of conductor compound between the mounting surfaces in order to better protect the connection in all environmental conditions and promote connection longevity.  

3) For GBL-4SS, GBL-4DBT or GBL-4DBTH, apply 35 in-lbs mounting torque to #10 mounting bolt.

4) For GBL-4DBT-14 or GBL-4DBTH-14, apply 72 in-lbs mounting torque to 1/4" mounting bolt.

5) Apply a liberal amount of conductor compound (ILSCO DE-OX oxide inhibitor) in wireway of ground lug.

6) Install ground conductor in lug and torque wire screw to the following:
   - 4 - 6 AWG: 35 in-lbs.
   - 8 AWG: 25 in-lbs.
   - 10 - 14 AWG: 20 in-lbs.

*Flat washer and split washer are not required.

Additional Information:

a) GBL-4SS, GBL-4DBT, GBL-4DBTH are suitable for use with flat-surfaced anodized aluminum or galvanized steel designated G90 minimum. The acceptable mounting hole diameter is 0.196 inches ± 0.004 inches (4.98mm ± 1mm).

b) GBL-4DBT-14, GBL-4DBTH-14 are suitable for use with flat-surfaced galvanized steel designated G90 minimum. The acceptable mounting hole diameter is 0.270 inches ± 0.004 inches (6.86mm ± 1mm).

(c) The acceptable framing material thickness is a minimum of 0.062 inches (1.57mm) to 0.250 inches (6.35mm), with a flat surface are of no less than 34 by 12mm (bottom of the lug).

(d) For use with Listed Photovoltaic Modules or Listed Mounting systems described in the Listed PV Modules or Listed Mounting System Installation Instructions.

(e) For sizing of an Equipment Grounding Conductor (EGC), the rating of the Overcurrent Protection Device (OCPD) in circuit ahead of the Equipment shall not exceed the values in NEC table 250.122 where the EGC is only required to be larger than the Circuit conductors supplying the equipment.

(f) For use with a Grounding Electrode Conductor (GEC), the size of the conductor shall comply with NEC articles 250.66 for AC systems and 250.166 for DC systems.

(g) Rated maximum system overcurrent protection (Cu conductor):
   - 14 AWG: 15A
   - 12 AWG: 20A
   - 10 AWG: 40A
   - 8 AWG: 90 A
   - 6 AWG: 150 A
   - 4 AWG: 200 A
11. Grounding and Bonding (cont.)

System Bonding Overview

1. Skirt row continuous bond:
   Continuous bond from Base and Clamp to Skirt. Couplings bond Skirt to Skirt. Complete row of Skirts and EcoX components clamped to Skirt are bonded.

2. Module row continuous bond:
   Continuous bond from Flashing through Clamp to Module. Couplings bond Module-to-Module. Complete row of Modules and EcoX components clamped to Modules are bonded.

3. Row to row bonding:
   Bond Clip added to uphill side of one Clamp per row. This bonds Skirt row to Modules on downhill row, and Module row to next Module row on each subsequent row.
11. Grounding and Bonding (cont.)

**Component Connections**

The following outlines bond connection mechanisms between Components:

**Clamp Assembly to Base:**
The Clamp Assembly slides onto the Base. The Strut Nut (highlighted in yellow) has teeth that embed in the Base.

**Clamp to Skirt:**
The Clamp features an integrated Bonding Clip. This Clip bites onto the Skirt on the downhill row.

**Coupling Bonds Skirt to Skirt:**
The Coupling features two integrated Bond Clips. These clips bond each Skirt to the neighboring Skirt.
11. Grounding and Bonding (cont.)

Component Connections (cont.)

**Clamp to Module:**
The Clamp features an integrated Bonding Clip. The Clamp bonds to the Module downhill from the Clamp.

**Coupling Bonds Module to Module:**
The Coupling features two integrated Bonding Clips. On module rows, the Coupling bonds each Module to the neighboring Module. The Coupling is not approved for bonding row-to-row.

**Bond Row to Row:**
Additional bonding must be added to bond the Skirt row to the first row of Modules, and to bond each row of Modules together. There are two options to accomplish this, they are as follows:

**Option 1:** Add a Bond Clip to the uphill side of each Clamp.

**Option 2:** Use an approved bonding jumper. A jumper is required between the Skirt and the first row of Modules, and between every row of Modules. Either side of the array is acceptable.
Appendix A: How to replace the Clamp Assembly with a Coupling

**A1. Disassemble Clamp Assembly and Rebuild using a Coupling**

**This situation requires a Coupling:**
When a Rafter falls where two Modules meet, the Clamp Assembly must be removed and replaced with a Coupling.

**Swap Clamp Assembly for Coupling:**
Disassemble and reassemble with Coupling. Reuse Strut Bolt, Glider, O-ring and Strut Nut.

---

Remove the Glider and Clamp assembly from the Base. Next, remove the Upper and Lower Clamps from the Glider by removing the Strut Bolt and Strut Nut. Position the Coupling onto the Glider and re-install the Strut Bolt and Strut Nut. Return the Glider to its original position on the Base. Align the Glider and Coupling to the Modules as described in sections 8, 9, and A-2. Tighten and torque the Strut Bolt and Coupling Clamp to 14 ft-lbs.

To ensure proper electrical bonding install the modified Coupling within the allowable left/right limits. The following page demonstrates the maximum allowable range of positions between the Coupling and Module Frame(s). Use the Alignment Marks and align to the Module Frame. Any less overlap inhibits proper bonding and may not properly support components.

---

This procedure is used only in those situations wherein adjusting Attachments (Step 8e) fail to resolve interference issues between an Attachment and a Coupling. A common example of this is shown at left when a rafter falls where two modules meet.
A2. Utilizing the Alignment Marks for Proper alignment of Coupling to Modules and Skirts

Acceptable Range of Positioning
Coupling has a maximum allowable range of positioning and must not exceed this range. Using Alignment Marks keeps the range in check.

Incorrect
Coupling position exceeds the allowable range. Alignment Mark is not in-line with Module Frame. Inadequate Module and Skirt support. Bonding will be inhibited.

Outermost Positioning - Scenario One
Alignment Marks properly aligned with Module Frame

Outermost Positioning - Scenario Two
Alignment Marks properly aligned with Module Frame

Just as in earlier steps, the Coupling must be properly aligned in order for bonding to occur and also to properly support the Modules and/or skirts.

For Modules that are constructed with non-metallic corners, ensure the Bonding Clip in the Coupling is fully engaged with the metallic frame of the Module as shown in step 9-e.

If the Coupling is not within the acceptable range of positioning the Bonding Clips (within its Upper Clamp) will fail to make proper contact with the Modules and/or Skirts. Correct positioning to the Alignment Marks ensures the Bonding Clips are making contact with the Modules and/or Skirts concluding in a proper bond.

When replacing a Clamp Assembly with a Coupling verify that the left/right positioning of the Coupling will fall within the acceptable range of positioning as shown to the left. Remember, after the Coupling is installed it is in a fixed left/right position and cannot be adjusted because it is secured to the Glider and Base attachment to the rooftop.
With natural ambient temperature fluctuations, thermal expansion and contraction can impact large arrays. To prevent excessive thermal movement in an array, thermal breaks should be installed for arrays longer than 35 ft. If the total left/right dimension of an array exceeds 35 ft, break array as shown to accommodate thermal expansion and contraction. Ensure each sub-array’s left/right length “L” do not exceed 35 ft. Add Clamps as necessary to support PV modules on each side of the thermal break without exceeding the allowable cantilever specified in the project specific engineering calculations. The left/right gap between sub-arrays should be set to a minimum of ½”. Note that the gap shown at left is much greater than ½” for demonstration purposes.

Use a bonding jumper to bond the two sub-arrays together. Alternatively, connect a separate Equipment Grounding Conductor (EGC) to a single point on each sub-array.
Appendix C: Service and Maintenance

Follow these procedures to ensure extended safety and performance.

Ecolibrium recommends periodic re-inspection of the installation for loose components, loose fasteners, and any corrosion, such that if found, the affected components are to be immediately replaced.

If module removal is required, it is the installer’s responsibility to ensure the ground path is maintained when the module is removed. One of two bonding options may be utilized:

**Option 1** (for use on a single row array):

A. Install an approved ground lug on adjacent modules.
   - Wiley WEEB-LUG-6.7
   - Ilsco Lay-in Lug GBL-4DBT
   - Burndy CL50-1TN
   Other UL 2703 listed, outdoor rated (by others) ground lugs may also be suitable for this system if approved by the AHJ (Authority Having Jurisdiction).

   Install ground lug on both of the modules adjacent to the module to be removed. Use the grounding hole on the frame of the module. See section 10 for additional ground lug information.

B. Connect a Bonding Jumper.
   Lay a bare #6 CU conductor (by others) into the two lay in lugs connected to the adjacent modules.

**Option 2** (for use on a multiple row array):

Install a row to row bonding on either end of the row.

- Install approved grounding lug per lug manufacturers instructions. See Section 10.
- Deburr any field-drilled holes.
- Wiley WEEB Lugs are “single use only”.

Ground Lug

#6 CU Conductor

Underside of Module
EcoX is rated to be installed with the following Modules according to the approval list.

### Appendix D: Modules Evaluated as part of EcoX UL 2703 Certification

Note: "XXX" represents module wattage.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Module Series</th>
<th>Downforce Design Load</th>
<th>Uplift Design Load</th>
<th>Downslope Design Load</th>
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(continued)
### Appendix D: Modules Evaluated as part of EcoX UL 2703 Certification (cont.)

EcoX is rated to be installed with the following Modules according to the approval list.

#### Note: "XXX" represents module wattage

<table>
<thead>
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<th>Manufacturer</th>
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<th>Downforce Design Load</th>
<th>Uplift Design Load</th>
<th>Downslope Design Load</th>
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The Ecolibrium Solar Power Accessory Bracket is tested to meet the UL2703 standards for grounding and bonding, and is compatible with any UL2703 solar racking system. In addition, the Power Accessory Bracket provides an adequate system ground path through power accessories with integrated grounding systems.

The Power Accessory Bracket is easily installed, and provides a secure, UL2703 approved bonded connection when installed according to the following criteria:

- The center of the bracket (installation bolt) must be placed within 12 in. of the corner of the PV module, as shown in Figure 1 (power accessory unit may be installed on short edge of PV module as well as on long edge as shown)
- The bracket must be fully inserted onto the return flange of the PV module (See Figure 2)
- The power accessory unit must face downward as shown in Figure 2
- The connection bolt must be tightened to a torque value of 14 ft-lbs as shown in Figure 2

Additionally, when the Power Accessory Bracket is used to install an Enphase unit with integrated grounding, the connection provides a UL2703 certified system ground path with a maximum OCP rating of 20 A. (For more information, please contact the Ecolibrium Solar sales team at 1-720-249-1877)
Appendix F: Installing the Skirt-Less Clamp Assemblies

1a. How to Set the Clamp Assembly Height via the Glider

Height settings are made by utilizing the 5-position dovetailed engagements of the Glider-to-Base. The image to the left shows three of these positions. 1" range of travel is possible in 1/4" increments. This equates to 1/8" variation from Glider to adjacent Glider to adjust and compensate for irregular or undulating roof tops.

Start by setting the Glider on the end-of-row Clamps to their middle position and then adjust other Clamps along the row as needed to level the row.

1b. Install the Clamp Assemblies

Alignment Marks

Set Glider at Approx. 1 inch

Acceptable range for uphill edge of Glider.

This Glider is aligned outside of the acceptable range and must be repositioned.
1c. Engage Strut Nut with Base

Use an impact driver to tighten the Strut Bolt and engage the Strut Nut channels with the two flanges of the Base. Leave the Clamp open to accept the Module. Further tightening will be done as the Modules are installed.

2a. Run a E-W String Line

Position String on top groove of the two outermost left/right Clamp Assemblies.

A String Line is used to level and align Clamp Assemblies on the first downhill row only. The body of the Glider includes one “String Groove” specifically designed to assist with this process. Run and secure the String Line between the two outermost left/right Clamp Assemblies. Place String on the top String Grooves, pulling it taught and securing its ends.

Torque to: 14 ft-lbs
Appendix F: Level and Align Clamp Assemblies (cont.)

2b. Level and Align to String Line

**Height Adjustments**

**Problem:**
Top Groove not aligned with String Line

**Solution:**
Raise Glider one Dovetail Engagement (1/4") to align Top Groove of Glider with String Line

**Uphill/Downhill Adjustments**

**Problem:**
Gap too large between String Line and Glider

**Solution:**
Reduce gap by sliding Glider Toward String leaving a gap of 1/16" or less
3a. Pivot Modules into Clamps & Couplings

1. Hold the module on its uphill edge, and place its downhill edge onto Gliders.
2. Pivot uphill edge downward toward the uphill Base.
3. Rest the Module on the Base.
4. Be certain that the Module Frame has fully seated into/against the Clamps.

Place Module on Gliders

Rest Module on uphill Base

Pivot Module downward while pushing it into the Clamp Assembly

Ensure that Module is fully seated in Clamp Assembly and Coupling

View looking from left edge

Uphill Base

module starting position

module resting position

Clamp Assembly
3b. Continue installing Modules across row

Working across the row set the Modules in place while leaving a \( \frac{1}{2} \)" gap between them. Set the gap by the alignment marks on the Coupling(s) and aligning the Module frames to these marks.

**Wiring**

As each row of Modules is installed, complete all wiring connections and verify that all wire management clips and wires are properly arranged and off the rooftop before proceeding to the next row of Modules.

- **Uphill**
  - Module Frame
  - 1/2" Gap
  - Module Frame

- **Coupling**
  - Module Frame Alignment Marks

**Note:** See following step on installing the Coupling.
Appendix F: Install Modules (cont.)

3c. Installing the Coupling

Install Coupling as shown utilizing its alignment marks to set the gap of the Modules. Tighten the two bolts and torque to 14 ft-lbs.

After installing the Couplings return to step 9c and continue the installation process.

Torque to: 14 ft-lbs

Install Coupling with this step butted against the Modules

4. Apply UL 2703 label

For Skirt-Free EcoX installations, apply one UL 2703 label per sub-array. Follow the instructions included along with UL 2703 labels in every box of End Couplings.

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Appendix G: Installing EcoX on a Membrane Roof

1. Determine attachment locations:
   Plan out the array on the roof and mark the location of each clamp using a chalk line or other appropriate method.

2. Install attachment flashings according to the manufacturer’s requirements:
   Install each attachment with the mounting stud centered on the locating mark from step 1.

3. Install the Flat Roof Base to the mounting stud:
   Place the mounting hole of the Flat Roof Base (ES10274) over the mounting stud and secure with the included Serrated Flange Nut. Tighten the nut to 14 ft-lbs.

4. Install modules and other components:
   Follow the instructions starting with section 6 on page 11 to complete the assembly.

Plan out the array on the roof and mark the location of each clamp using a chalk line or other appropriate method. Install each attachment with the mounting stud centered on the locating mark from step 1. Place the mounting hole of the Flat Roof Base (ES10274) over the mounting stud and secure with the included Serrated Flange Nut. Tighten the nut to 14 ft-lbs. Follow the instructions starting with section 6 on page 11 to complete the assembly.

Torque to: 14 ft-lbs