



# Application Note

## FS Series 4 PV Module Mounting

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The information contained in this application note is intended to provide designers of First Solar PV module mounting and support systems with both minimum requirements and recommendations for the development of mounting solutions which will satisfy First Solar's technical and mechanical requirements to provide a safe and approved solution for the installation of all First Solar FS Series 4 laminate PV modules (i.e. FS-4XXX, FS-4XXX-A, etc...). North American users requiring the use of Underwriters Laboratories (UL) listed components please reference PD-5-320-04 NA.

The information contained in this document is not exhaustive and does not consider all technical design requirements. It rather provides the minimum required mounting provisions to ensure First Solar FS Series PV Modules perform in a safe, compliant and reliable manner.

Compliance with these recommended requirements will not, by itself, result in a fully approved PV System design.

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**Important:** It is the responsibility of vendors, customers, installers, design professionals, and engineers to follow a due diligence process to ensure the structure meets applicable structural and electrical code requirements of the jurisdiction where the product will be sold or installed. First Solar is not responsible for bonding failure, breakage, damage, wear or module performance issues that are deemed to be caused by design or installation practices.

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First Solar is not responsible for the cost associated with the development or manufacture of prototypes. Please see the appropriate First Solar FS Series PV Module User Guide for further information about the First Solar laminate PV module product in your region of application.

## Module Physical Specifications and Dimensions

Module physical dimensions provided below are for reference only. Refer to product drawing PRD-027-A for exact dimensions and tolerances of module.

Length	1200mm (-0.79mm/+5mm) [47.24 inch -0.031 in/+0.197in]
Width	600mm (-0.79mm/+5mm) [23.62 inch -0.031 in/+0.197in]
Thickness	6.8mm ( $\pm 0.2$ mm) [.267 inch $\pm 0.008$ inch]
Weight	12 kg [26.5 lb]
Area	0.72m <sup>2</sup> [7.75 ft <sup>2</sup> ]

## Module Mounting Locations

The module shall be secured to the support structure with clips (or equivalent) located at four (4) symmetrical points. The location of the clips must be along the 1200mm [47.24 inch] length of the module, and the center point of the clip IDEALLY SHOULD be located between 250mm and 300mm [9.84 inches and 11.81 inches] from the module corner. Figure 1 and Figure 2 depict the modules' retaining clips locations. Other alternate spacings such as  $250 \pm 25$  have been successfully tested through the requirements in this document and require specific approval. For such systems, please see the Clip and Mounting System Approval and the Mounting Clip Design Approval sections below.

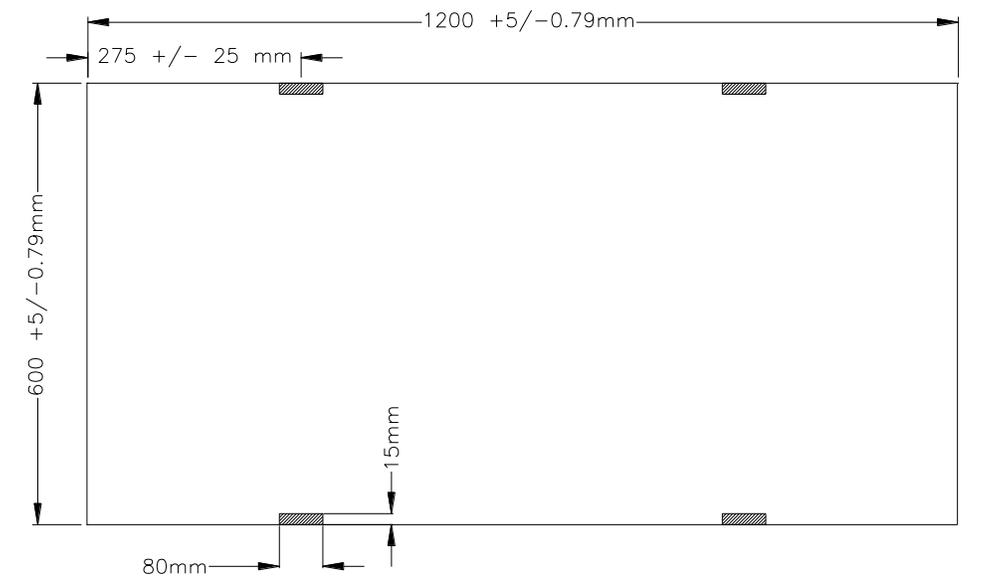


Figure 1. Recommended location of retaining clips (front side)

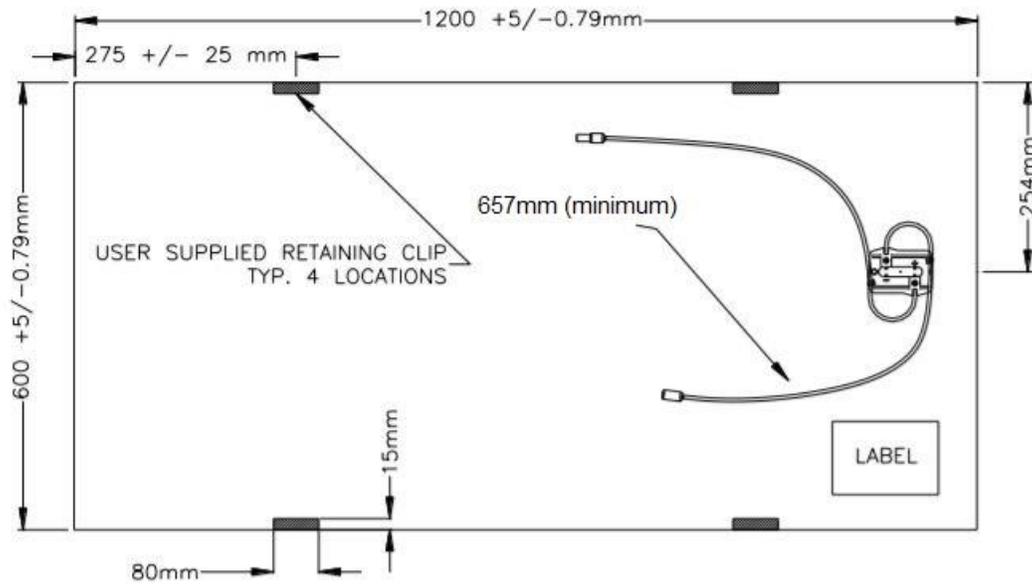


Figure 2. Recommended Location of Retaining Clips (back side)

## Mounting Structure and Clip Shading Considerations

When module cells are sharply shaded over their full length by structural components, the modules' cells may experience localized areas of reverse bias (negative voltage/positive current) that may result in damage.

- While there exist countless ways to shade a module, a few typical field scenarios that pertain directly to clips and structural components can be divided into no risk and high risk.
- **No Risk:** Shading of active area under typical module mounting clips mounted on long edges of modules poses no risk to reliability or performance.
- **High Risk:** A structural component or mounting method on the short edge(s) of modules that fully shades the entire length of a cell (either partial or complete width of cell) can create a high risk of undesirable shading.

## Module Orientation Specifications

Module mounting in landscape orientation is required for any tilted applications where row-to-row shading is present. Portrait orientation is prohibited where row-to-row shading is present. Portrait orientation is allowed where no row-to-row shading is present (i.e. a flat rooftop or parallel to tilted rooftop). Tilted portrait mounting requires a slide protection. Please see the appropriate First Solar Module User Guide for additional information on application, design, and operation.

## Retaining Clip and Mounting System Required Minimum Specifications

First Solar requires that a module retaining clip and mounting system must meet the following minimum specifications:

- The retaining clip and mounting system (retaining system) shall not compromise the integrity of the module as verified by testing per IEC 61215 MQT 16 to approved FS load requirements.
- The retaining system must not allow module deflection exceeding 0.01 mm/mm [0.01 inch/inch] in any direction. This includes the components and mounting structure the module is installed with, which must not ultimately result in module deflection exceeding 0.01mm/mm.
- The clip and support rail retaining system shall be designed in combination with one another and must have a gap on the vertical edge to the module of 1mm [0.04 inches] to allow for thermal expansion in the width and length of the module glass. See Figure 3 below.
- A minimum gap of 10mm [0.4 inch] between two modules is required to prevent the contact between the modules. The recommended nominal gap is 20 mm.
- The retaining clip shall have a “hard stop” that limits the top and bottom surfaces of the insulator material compression by a maximum of 10% at maximum torque of fastening hardware.
- The retaining clip shall provide a gap of less than 6.8mm +/-0.2 [0.27 in +/-0.008in] to allow for the thickness of the module and when installed, the insulator material shall compress in a range of 5% to 10% at maximum hardware torque.

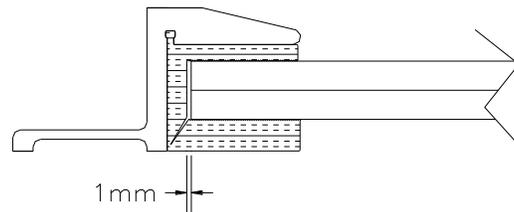


Figure 3. Example of a module with a 1mm gap from the vertical edge of the clip

## Clip & Mounting System Recommended Minimum Specifications

First Solar recommends that a module retaining clip and mounting system should meet the following recommended minimum specifications, which are intended to be guidelines and not absolute design requirements:

- A module surface contact length of 70mm [2.76 inches] (80mm [3.15 inches] preferred)
- Front side module surface contact width between 13mm (0.51 inches) and 15mm [0.6 inches]
- Minimum back side module surface contact width of 15mm [0.6 inches]

The retaining clips may be designed to support the module from either both the front side and back side surfaces, or only the front side surface. If the clip is designed to support and retain the module only at the module’s front side surface, the design and profile of the support rails to which the clips are mounted must be taken into consideration to satisfy the minimum back side surface contact width.

## Support Rail Specifications

Module support rails (or equivalent) shall be designed to provide a uniform plane for installation for the modules and module rail deflection shall not exceed the maximum deflection specified above. The support rails shall be designed to support the modules, either across the 600mm [23.62 inch] width of the module or along the entire span of the 1200mm [47.24 inch] length of the module. See Figure 4, Details A, B, and C below.

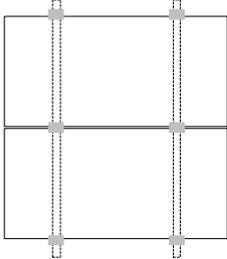
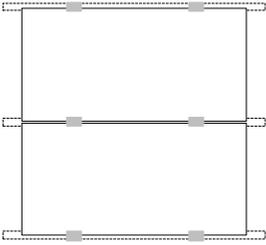
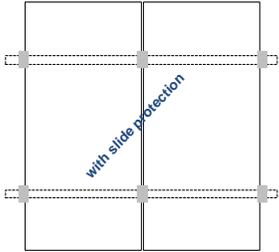
		
<p>Detail A:</p> <ul style="list-style-type: none"> <li>• Two support rails oriented north/south, mounted in parallel</li> <li>• Modules are mounted in landscape orientation across two support rails</li> </ul>	<p>Detail B:</p> <ul style="list-style-type: none"> <li>• Three support rails mounted in parallel, oriented west/east</li> <li>• Modules are mounted in landscape orientation parallel to support rails</li> </ul> <p>NOTE: Support rails with asymmetric profiles such as C or Z type channels may exhibit failure modes that can cause module dislodgement and/or breakage. First Solar recommends end users perform validation static load testing of the proposed mounting design per IEC 61215 MQT 16 to approved FS load requirements.</p>	<p>Detail C (Rooftop Only):</p> <ul style="list-style-type: none"> <li>• Two support rails oriented west/east, mounted in parallel</li> <li>• Modules are mounted in portrait orientation across two support rails</li> </ul>
<p>Mounting Direction 1<sup>1</sup></p>	<p>Mounting Direction 2</p>	<p>Mounting Direction 3</p>

Figure 4. Support Rails and Module Orientations

<sup>1</sup> Description used for the mounting system design in the Global Site Registration.

Module retaining clips can be either a one-part or two-part design (separate top half and bottom half). See details A and B in Figure 5.

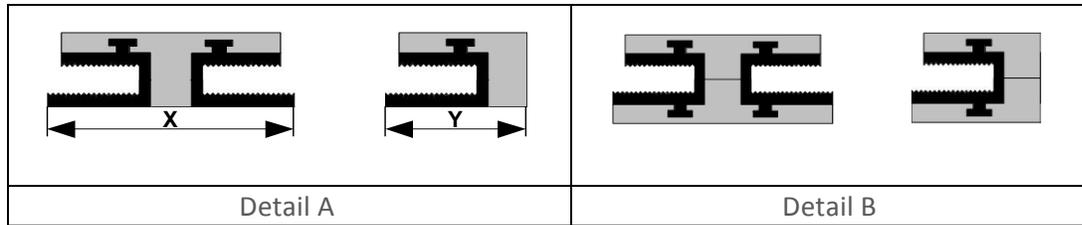


Figure 5. One-part and Two-part clips

If a two-part clip design is used, then the width of the underlying module rail is not relevant, but the module rail shall not exceed the maximum deflection specified.

If a one-part clip design is used, Table 1 below defines the support rail width and contact surface area width for the two typical module support rail orientations. Alternate rail width needs individual review, testing and approval for specific application. The module rail deflection shall not exceed the maximum deflection specified. See Figure 6 Details A, B, C, and D for examples of module rails and the required module surface contact.

Module Retaining Clip Type	Figure 6	Rail Span Direction	Minimum Rail Width	Minimum Rail Contact Surface Width
One-Part design	Detail A	Along module width	40mm [1.6 in]	30mm [1.2 in]
One-Part design	Detail B	Along module length	Same as Clip and rubber insert (15mm)	Same as Clip and rubber insert (15mm)

Table 1. Support Rail Width and Contact Surface Width Requirements

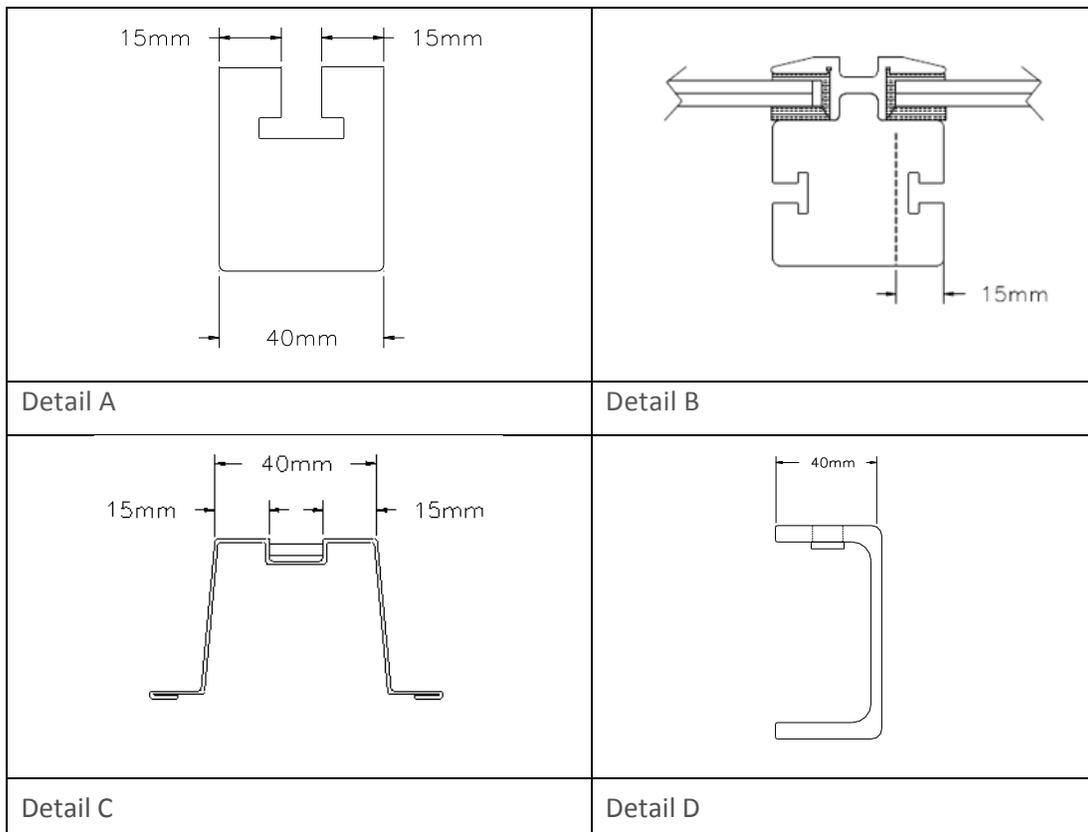


Figure 6. Module rail sample profiles and critical rail dimensions

Module support rails, clips, and rubber shall be fabricated from corrosion and UV resistant materials (ex. pre-galvanized steel, hot dipped galvanized steel, aluminum, stainless steel, powder-coated steel, etc.) that will maintain structural integrity over the lifespan of the modules (minimum 25 years).

## Fasteners

It is the responsibility of vendors, customers, installers, design professionals, and engineers to follow a due diligence process to ensure fasteners used prevent galvanic corrosion, environmental corrosion, and provide electrical bonding between the clip and underlying structure as defined by local codes and jurisdictions. First Solar does not make recommendations or test fasteners for these requirements. Fasteners used in the mounting system testing provided by vendors, customers, installers, design professionals, and engineers are expected to meet all these and necessary mechanical strength requirements.

## Insulators and Protective Materials

Laminate modules must be electrically insulated and protected from direct contact with metallic surfaces of retaining clips, support rails, or other structural support components. Insulation and protective materials tested and approved for use by First Solar for FS Series 4 modules are typically Thermoplastic Elastomer (TPE) materials such as a cross-linked EPDM+Polypropylene blend or equivalent and must have the minimum thickness specified in Figure 7. Minimal material thickness is 3mm for the top and bottom sections, and 2mm for the vertical section, both with volume resistivity >  $1.0 \times 10^{14} \Omega \cdot \text{cm}$  per ASTM D257.

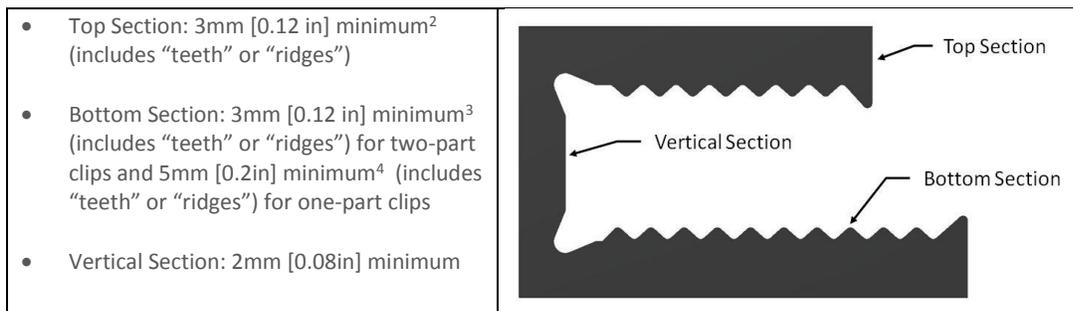


Figure 7. Clip Insulator Minimum Dimensions

Insulator materials shall be UV resistant and designed to maintain integrity over the lifespan of the modules (minimum 25 years). Typical rubber durometers range from 45 to 75 on the Shore A scale.

<sup>2</sup> Minimum: Manufacturer material low tolerance thickness when compressed 10%

<sup>3</sup> Minimum: Manufacturer material low tolerance thickness when compressed 10%

<sup>4</sup> Minimum: Manufacturer material low tolerance thickness when compressed 10%

## Moisture Drainage and Air Circulation

Retaining clips shall be designed and installed to facilitate drainage at the module interface, and should be designed to prevent the trapping of moisture inside of the clip or at the edge of the laminate module.

In addition, the module structure should be designed to maximize air flow under the module to control the module operating temperature.

## Clip and Mounting System Approval

First Solar reserves the right to internally test samples of proposed retaining clip and support rail designs prior to approval for use with First Solar modules. First Solar may, at First Solar's sole discretion, test the supplied samples per the procedures defined in IEC 61215 MQT 16 (Test Load to 2400Pa), UL 1703 section 41 (Mechanical Loading Test to 2154Pa), and/or other tests deemed appropriate by First Solar. If multiple retaining clip and module rail profile combinations are available, all combinations shall be disclosed to First Solar for review and testing to worst case scenario. Samples submitted to First Solar for testing shall be supplied with the respective clips, fasteners and module rails as per submitted design drawings.

It is the responsibility of vendors, customers, installers, design professionals, and engineers to perform static load test as defined in IEC 61215 MQT 16 and verify compliance prior to submitting samples to First Solar for approval.

Maximum allowable pressure on modules may not exceed 2400 Pa (50.13 lb/ft<sup>2</sup>) without additional module support or design that must be tested and approved by First Solar to receive a project specific approval.

Any mounting solution that deviates from the dimensional guidance for the clip, rails, or mounting configuration as specified above shall be considered to be in compliance with this document if it has been proven with high confidence (sample size >5 per configuration) to pass the test procedures defined in IEC 61215 MQT 16 (Test Load to 2400Pa), IEC 61730 MST 32 (Module Breakage Test), UL 1703 section 41 (Mechanical Loading Test to 2154Pa), IEC 62782 Dynamic Mechanical Loading and/or other tests deemed appropriate by First Solar. A detailed test report that documents the test setup, method and results shall be provided to First Solar for review and approval.

## Mounting Clip Design Approval Process

First Solar module warranty requires that module mounting hardware is reviewed and approved as part of First Solar's Global Site Registration Process. Required documentation is outlined below and should be submitted to the First Solar Technical Support team<sup>5</sup>.

- Part drawing(s) of the proposed retaining clips, insulator, fasteners and number of support rails with critical dimensions
- Official Insulator Datasheet
- Assembly drawing(s) of the proposed module, retaining clip, and support rail assembly with critical dimensions and specified fasteners
- Assembly instructions with mounting location and fastener torque specifications
- Detailed description of any special tools or equipment needed for assembly

Upon receiving the above items, First Solar will review the proposed design and decide to either accept to test or reject the proposed design. If the design is accepted, First Solar will request all of the following to mount two modules as shown in Figure 4 Details A and B:

- Samples of the clips (4 end clips, 2 mid clips) with rubber inserts
- Module mounting rails (minimum of 1600mm per rail)
- All hardware and fasteners needed for mounting the two modules

If the testing is successful, First Solar will provide an FS Clip Number (PD-5-321-XXX) and a confirmation of compliance.

A copy of all submitted drawings and samples will be retained by First Solar for historical record. First Solar reserves the right to charge for mounting system approval and testing.

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<sup>5</sup> The First Solar Technical Team can be contacted at [technicalsupport@firstsolar.com](mailto:technicalsupport@firstsolar.com)