

# **Sigma Steel**

## Installation manual





Sigma Steel

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# 1. Introduction

## 1.1 Short Description

Sigma Steel is an open field, single post, PV ground mount system. It allows a flexible arrangement of modules in portrait or landscape orientation. The Sigma Steel can be anchored with driven piles or cast in concrete. It consists of a corrosion-resistant coated steel substructure with stainless steel fasteners and aluminum clamps.

## 1.2 About These Instructions

### Content

These instructions describe the installation of the Sigma Steel mounting system and provide necessary information regarding components, system planning and important safety warnings. Sections 1, 2 and 3 provide an overview as well as detailed information about the Sigma Steel system and components. Section 4 provides basic module layout and planning information. The remaining sections provide detailed system assembly and installation instructions.

### Applicable Documents

Please read this manual carefully. The manual, along with the relevant project-specific Project Drawings and Bills of Materials (BOM) provided by Mounting Systems, contains the information necessary to complete the

assembly and installation of the product safely and correctly. In addition to these documents, the document "Installation Instructions for PV Mounting Systems: General Information" should be referenced as well. This document provides general information for Mounting Systems products regarding standardization, safety, transport, maintenance, disassembly and disposal. Both this manual and the "Installation Instructions for PV Mounting Systems: General Information" are an integral part of the Sigma Steel system and must be adhered to for each installation.

**It is important that you carefully read these Instructions as well as all applicable documents prior to carrying out any installation, maintenance or disassembly work. These instructions provide you with the information required for the safe and complete installation, maintenance and disassembly of the Sigma Steel. Should you have any questions, please contact Mounting Systems, Inc.**

### Pictograms:



This symbol indicates important information and useful tips.



This symbol indicates ways and means to make the installation process easier.

### 1.3 Warnings

The following warnings are used in these Installation Instructions to indicate safety-related information. They include:

- Warning symbols (pictograms)
- Signal words which identify the hazard level
- Information about the type and source of the hazard
- Information about the potential consequences if the hazard is disregarded
- Measures for the prevention of hazards and the prevention of injuries or damage to property.

The signal words of the warnings respectively indicate one of the following hazard levels:



Indicates a potentially mortal danger, disregard for which may result in death or serious injury.



Indicates a potentially dangerous situation which may result in serious injury or damage to property.



Indicates a potentially dangerous situation which may result in injuries or damage to the property if ignored.



Indicates potential danger which can result in damage to the property.

### 1.4 Safety

All generally applicable safety regulations for Mounting Systems, Inc. products can be viewed in the document "Installation Instructions for PV mounting Systems: General Information". Please read this document carefully and adhere to the instructions and procedures therein – use the system only for its intended purpose and follow both the general and specific safety instructions. In addition, please observe the specific safety instructions which precede the process steps in the present product-specific Mounting Instructions.

This system is designed to be installed with 60 or 72-cell modules in landscape or portrait installation. 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.

## 2. Sigma Steel Components

Upon delivery of the Sigma Steel system, check to ensure that all parts and components as described in the Bill of Materials and the Project Drawings are present. If an item is missing or damaged, please document the discrepancy and notify Mounting Systems, Inc. immediately.

### 2.1 System Overview

In general, a Sigma Steel system always includes the items shown in the typical system views below.



*Image 2.1 - 1 Portait module configuration*

Sigma Steel system components:

- a** Module rails
- b** Rafters
- c** Diagonals
- d** Foundation (driven pile or earth screw)
- e** Module mid clamps and module end clamps
- f** Splices\*
- g** Assembly materials / small parts\*

\* Not shown in the diagrams

## 2.2 Component Detail



Image 2.2 - 1 **Foundation**



Image 2.2 - 2 **Rafter adapter**



Image 2.2 - 3 **Steel diagonal**



Image 2.2 - 4 **Aluminum diagonal assembly**



Image 2.2 - 5 **Rafter assembly with diagonals\***



Image 2.2 - 6 **Module rail**

\* Steel or aluminum diagonals



Image 2.2 - 7 **Module rail clamp**



Image 2.2 - 8 **Module rail splice**

### Module Clamps

Module clamps are used to secure the PV modules to the Sigma Steel module rails. All module clamps are equipped with a Mounting Systems' Clickstone, a special clip that clicks into the module rail. Module end clamps are installed at the ends of the module rails. End clamps are available in discrete sizes or with variable ranges. Module mid clamps are used to hold PV modules in the center of the module rails. All module clamps are pre-assembled and integrally bonded.



Image 2.2 - 9 **Fixed height module end clamp**

### Module End Clamps

Fixed height module end clamps are supplied for discrete module thicknesses as shown in Image 2.2 - 9.

### Module Mid Clamps

Mid clamps are integrally bonded with a bonding plate during pre-assembly as shown in Image 2.2 - 10. These clamps create a high-ampacity bond to the module when installed properly and torqued to the required setting. Mid clamps are available in functional ranges from 28-40mm, 33-45mm and 38-50mm.



Image 2.2 - 10 **Bonding plate mid clamp**

### 3. System Bonding and Grounding

The Sigma I XL-ST system is designed with integrated electrical bonding of all component parts. This integrated bonding requires adherence to these installation instructions, particularly in regard to proper installation and tightening of the various Sigma Steel connection components.

#### 3.1 System Bonding

##### Clickstone Bonding

As shown in Images 3.1 - 1 and 3.1 - 2, the Sigma Steel Clickstones and rails are designed with complementary, sharp bonding hooks. When the Clickstone clamp is installed in the module rail and the bolt is tightened, the bolt forces the hooks into the rail. Then, as the clamp engages the module and the bolt is tightened to the recommended torque specification [12 ft-lbf (16 N-m)], these hooks are pulled tightly together and penetrate the coating on the rail and electrically connect the rail, Clickstone and Clickstone bolt. A star washer under the bolt head serves to connect the Clickstone bolt to the body of the mid or end clamp thus forming a secure, high-ampacity electrical bonding path as shown in Image 3.1 - 3.

##### Module Rail Splice Bonding

The module rail splice is preassembled with the bolts welded on. When splicing two rails together, the preassembled bolts are installed into both rails and serrated flange nuts secure the splice, creating a high-ampacity bond between both rails and the splice when properly torqued.

##### Module Rail and Rafter Bonding

The module rail is clamped to the rafter with a module rail clamp. This clamp has sharp bonding points on both sides to pierce the coating of both rails and create a high-ampacity bond when properly torqued.

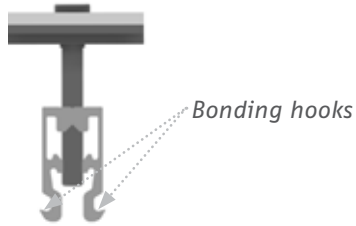


Image 3.1 - 1 Clickstone bonding hooks

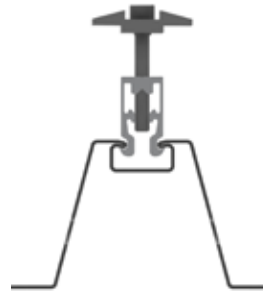


Image 3.1 - 2 Clickstone rail bonding hooks



Image 3.1 - 3 Module rail splice bonding

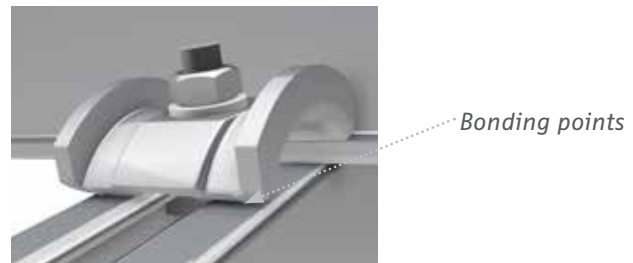


Image 3.1 - 4 Module rail clamp bonding



### Rafter Adapter Bonding

The rafter adapter has sharp bonding points on all of the pre-punched holes. The rafter is placed over the top of the adapter and is connected with a bolt and nut. The adapter plates are separated to slide down over the post and connected with a bolt and nut assembly. Upon tightening all the bolts, the rafter adapter will create a secure, high-ampactiy bond fom the rafter through to adapter to the post.

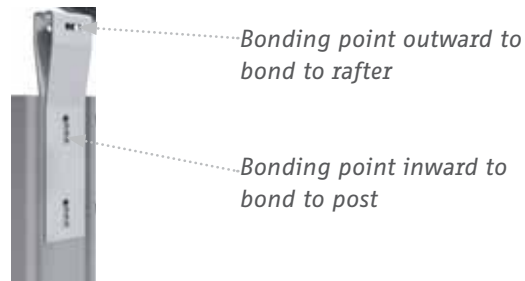


Image 3.1 - 5 Rafter adapter bonding

### 3.2 System Grounding

Each table must be connected to the system ground electrode by using a WEEB-Lug 8.2 or other grounding device. The WEEB-Lug has a grounding symbol located on the lug assembly. Installation must be in accordance with the latest National Electrical Code.

The grounding lug is installed on the rafter or module rail with a pre-assembled T-bolt so the lug is perpendicular to the rail channel. When the lug is properly torqued to the required specifications, the bonding nubs on the WEEB Lug bond to the rail and connect the entire array to the grounding wire. This grounding wire should then be used to take the entire bonded array to ground. One lug is required for each separate array table.

Sigma Steel is intended to be installed with modules that are rated to the following specifications: maximum of 1,000 VDC, maximum series fuse rating of 20 A, maximum of 5,400 Pa, and at least a Class C Fire Rating<sup>1</sup>. This system is specifically designed for each project. Please refer to the project specific documentation for structural load requirements, cable management and other project-based data.

AWG Wire Size	WEEB-Lug 8.2 Capacity
14-6	1 wire
10	2 wires
12	2 wires

Table 3.2 - 1



Image 3.2 - 1 Copper wire in WEEB-Lug 8.2

<sup>1</sup> Other module specifications can be verified upon request.

## 4. Project Drawings and Bill of Materials

Project-specific documentation is supplied as part of the Sigma Steel system. It contains all the information necessary to install the system.

The documentation includes:

- Bill of Materials (BOM)
- System overview drawing(s) which show:
  - component variations specific to the project
  - specific foundation information for the project, including orientation of piles
  - the parts supplied for bolted connections specific to the project
  - the exact module configuration for the project

## 5. Basic Installation Requirements

### 5.1 Tightening Torques

A good quality torque wrench should be used to tighten bolted connections to the torque requirements shown below:

<b>Bolt size</b>	<b>Recommended torque</b>
<i>M6 Mid clamp Clickstone bolt</i>	<i>12 ft-lbf (16 N-m)</i>
<i>M6 End clamp Clickstone bolt</i>	<i>8-10 ft-lbf (11-13 N-m)</i>
<i>M8 Module rail adapter clamp</i>	<i>15-18 ft-lbf (20-25 N-m)</i>
<i>M10 Splice nut</i>	<i>15-18 ft-lbf (20-25 N-m)</i>
<i>M10x60 Rafter adapter</i>	<i>12-15 ft-lbf (16-20 N-m)</i>
<i>M10x30 Rafter adapter</i>	<i>20-25 ft-lbf (40 N-m)</i>
<i>M10x30 Steel diagonal to pile</i>	<i>20-25 ft-lbf (40 N-m)</i>
<i>M10x30 Aluminum diagonal to pile</i>	<i>15 ft-lbf (20 N-m)</i>
<i>M10x60 Diagonal to rafter</i>	<i>7-10 ft-lbf (10-13 N-m)</i>
<i>Aluminum diagonal adapter (pre-assembled)</i>	<i>12-15 ft-lbf (16-20 N-m)</i>
<i>M8 WEEB Lug bolt</i>	<i>12-15 ft-lbf (16-20 N-m)</i>

The recommended tools are shown below for each bolt size:

<b>Bolt size</b>	<b>Recommended Tool</b>
<i>M6 allen bolt (Clickstone)</i>	<i>M5 Allen key</i>
<i>M8 bolt (rail clamp and WEEB)</i>	<i>13mm Socket</i>
<i>M10 hex bolt</i>	<i>17mm Socket</i>
<i>M10 flanged bolt</i>	<i>15mm Socket</i>

## 6 Foundation

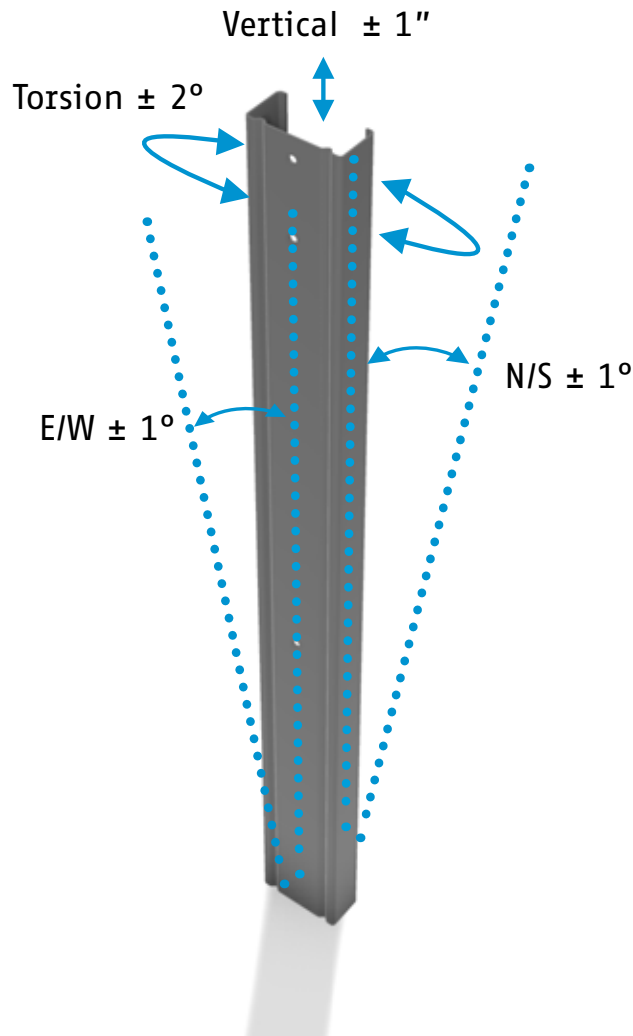
### 6.1 Installation of the Driven Piles

The overall orientation, with all piles facing the same direction, will be specified in the project-specific documentation.

Ensure that the piles are positioned and installed within the tolerances noted below.



Image 6.1 - 1 Driven piles face the same direction



## 7. Sigma I XL-ST Superstructure Assembly

### 7.1. Install Rafter-Diagonal Assembly

The rafter adapter should be installed once the foundation is completed. The rafter adapter is adjustable in the vertical direction to compensate for any unevenness of the piles.

#### Rafter Adapter Installation Steps

- Place the rafter adapter plates on either side of the driven pile. Align the holes in the adapter plate to the pile as shown in Image 7.1 - 1 and assemble bolt/nut connection and tighten.
- Position the rafter in the correct north-south orientation and place it over the adapter plate. Align the holes as shown in Image 7.1 - 2. Insert the bolt in the desired hole and hand tighten the nuts. The finished installation is shown in Image 7.1 - 2.

There are two different diagonals included in Sigma I XL-ST: steel diagonal as shown in Image 7.1 - 3 and aluminum diagonal and adapter as shown in Image 7.1 - 4. The diagonal type will be specified in the project-specific documentation, and the rafter pre-assembly is the same with either diagonal. The following installation steps apply to both diagonal types.



Image 7.1 - 1 Rafter adapter assembly



Image 7.1 - 2 Rafter adapter assembly



Image 7.1 - 3 Steel diagonal



Image 7.1 - 4 Aluminum diagonal with adapter

The design could have a one-diagonal design or a two-diagonal design. Check the project-specific documentation for the detailed design. In both cases, the diagonal(s) will be preassembled to the rafter for easier installation.

#### Diagonal Installation Steps, One Diagonal

- For one-diagonal installation, align the free end of the diagonal with the hole in the pile. Insert the bolt from the outside and hand tighten the nut.
- Ensure the entire array is correctly aligned. Once it is level, tighten all connections to the required torque specifications.

#### Diagonal Installation Steps, Two Diagonals

- For two-diagonal installation, align the rafter in the correct North-South orientation based on the project specific documentation.
- Rotate the rafter subassembly so both diagonals line up with their respective holes. Once the correct tilt is achieved and the holes align, insert the bolts from the outside and hand tighten the nuts.
- Ensure the entire array is correctly aligned. Once it is level, tighten all connections to the required torque specifications.



Image 7.1 - 2 One diagonal configuration



Image 7.1 - 3 Two diagonal configuration

## 7.2 Install Module Rail

The Sigma I XL-ST system uses module rails (Image 7.2 - 1) mounted on the rafters to hold the modules in place. Module rail clamps (Image 7.2 - 1) are used to mount the module rails to the rafters. Follow these steps and the project-specific documentation for specific measurements.

### Installation Steps

- Insert module rail clamp at the lower (south) end of each rafter. Tighten the T-head bolt only enough (2-3 turns) to hold the clamps in place in the rafter as shown in Image 7.2 - 1.
- Position a long module rail on the rafters with the left (west) end of the rail extending to the distance shown on the project-specific documentation and position the flange at the bottom of the rail's side channel under the lip of the module rail clamps as shown in Image 7.2 - 2.
- Align the rail and clamp perpendicular to the rafters and tighten the clamps only enough to hold the rail in place.
- Install module rail clamps in the rafters on the upper (north) side of the module rail and position them over the rail flange. Once the module rails are all aligned properly, tighten all the module rail clamps to the required torque.
- Using the project-specific documentation provided with the Sigma I XL-ST system, measure and position the remaining rails and clamps as called for in the documentation and install them as described in the above steps.

#### Hint!

To make positioning the clamps and rails easier, after installing the first rail, use the dimensions provided in the project-specific documentation for your system and measure and mark the positions of each module rail on the left-most (west) and right-most (east) rafters. Snap a chalk line between the corresponding points to mark the rail positions on each of the middle rafters.

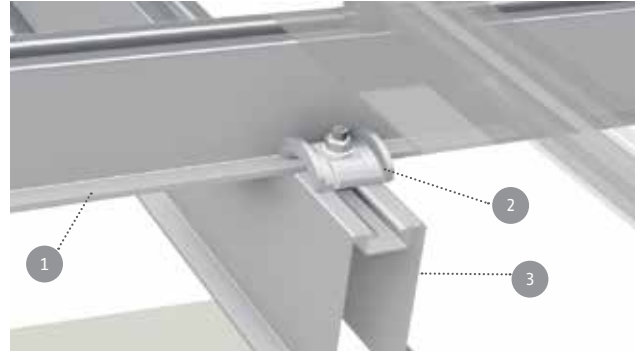


Image 7.2 - 1 **Install module rail clamps**

- 1 Module rail
- 2 Module clamps
- 3 Rafter

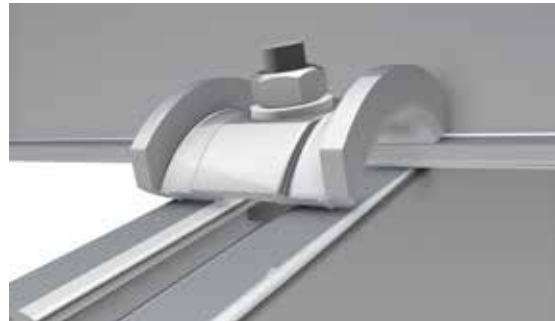


Image 7.2 - 2 **Module rail clamp installed**



Image 7.2 - 3 **Module rail installed, profile view**

### 7.3 Install Module Rail Splice

The module rails are spliced together with a module rail splice as shown in Images 7.3 - 1 through 7.3 - 3.

- To connect two module rails together, align them on the rafter as shown in Image 7.3 - 1. Insert one inner splice inside the module rail and push the 4 pre-assembled bolts through the holes in the module rail towards the outside. Fasten with the provided washers and nuts as shown in Image 7.3 - 2 and tighten to the required torque.
- Fasten the other side of the splice the same way as described above and tighten. The finished splice should be installed on either side of the module rails and secure the two together as shown in Images 7.3 - 2 and 7.3 - 3.
- Repeat above steps for remaining module rail splices.

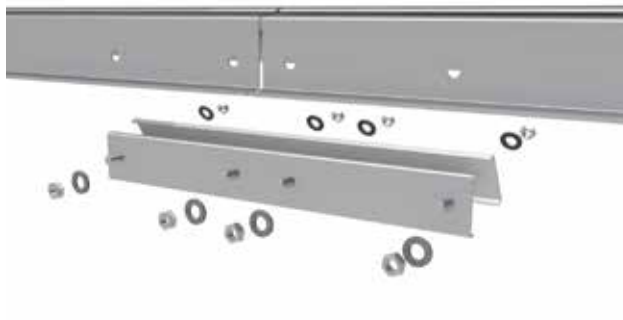


Image 7.3 - 1 Module rail splice and hardware



Image 7.3 - 2 Installed rail splice

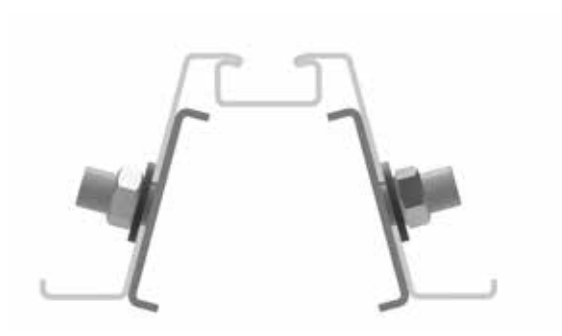


Image 7.3 - 3 Installed rail splice profile view

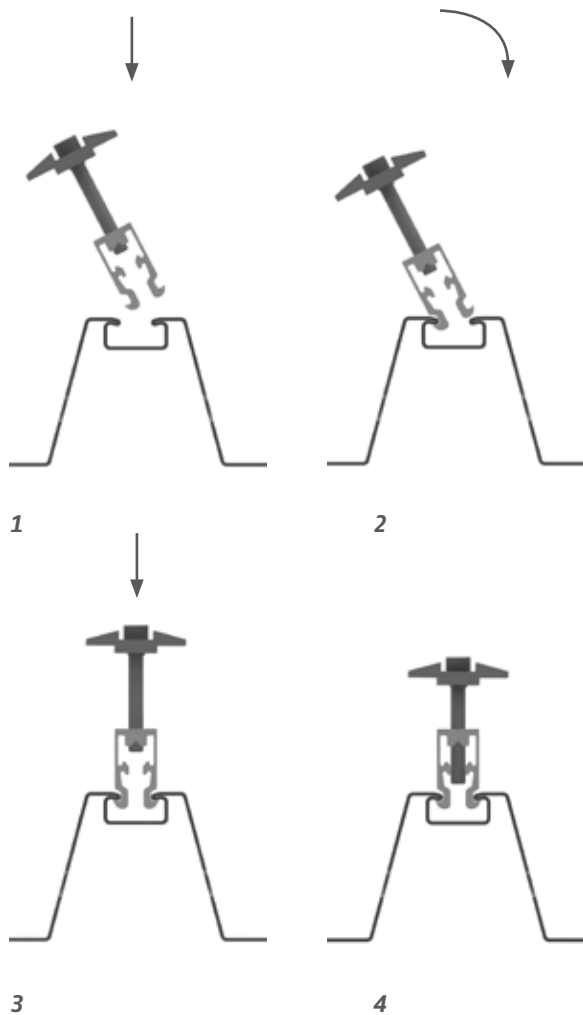


Image 8.1 - 1 Mounting steps from top left to bottom right

## 8. Module Installation

### 8.1 Installing Clickstones

Mounting Systems' Clickstone is a special clip with which the module clamps are fastened in the module rail. Only a 5mm Allen key is needed for the installation. The Clickstone is inserted from above into the top channel of the module rail.

#### Installation Steps:

- Insert the Clickstone at a slight angle into the rail channel.
- While holding it firmly in place, rock the Clickstone upright until it clicks into place.



#### NOTE!

The shape of the Clickstone corresponds exactly to the profile of the rail channel. It has been deliberately designed not to slide easily in order to prevent unintentional slipping during installations. To move the Clickstone, loosen the bolt so that it is not contacting the spreaders in the Clickstone body. Then, while pressing lightly on the bolt, squeeze the Clickstone legs together and slide the Clickstone along the channel.

- End clamps should be tightened to 6-8 ft-lbf (8-11 N-m).
- Mid clamps should be tightened to 12 ft-lbf (16 N-m).



## 8.2 Module Installation

The procedure below describes the installation of modules on a single row. This procedure begins on the west end of the array and moves east. Modules can also be installed from east to west if desired.

- Insert the Clickstone of an end clamp into each module rail ensuring the end clamps are correctly positioned on the rails and aligned with each other vertically (N-S).
- Place the first PV module on the rails and slide the module frame against the end clamps. With the module's clamping points correctly positioned under the end clamps, tighten the end clamps onto the module frame. Torque the Clickstone bolts to the required value.
- Insert a mid clamp into each module rail. Push it flush against the module, ensuring the clamp body rests on top of the previously installed module frame.
- Place the next module below the first one to complete the column. Push the module frame against the module end clamps and leave a small gap between this module and the top one. Once the module is in place, torque the Clickstone bolts of the end clamps to the required value. This column is now complete
- Place the next mid clamp against the bottom module, ensuring the clamp body is on top of the module frame. Place the next module for the top row on the module rail and slide it against the mid clamps. Tighten the mid clamp bolts to the required torque to secure both modules.
- Repeat this step for the bottom module to complete the second column.
- Repeat the above steps for the remaining columns. For the last column, install end clamps on the outside of the last modules to complete the table.

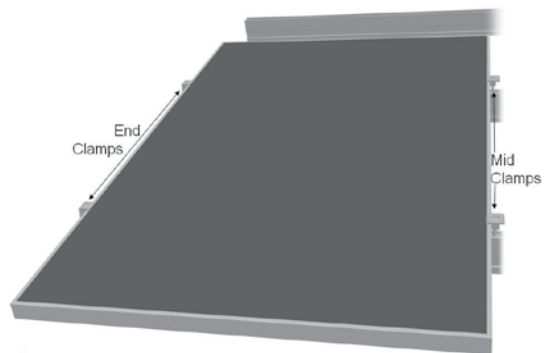


Image 8.2 - 1 Installation clamp locations



Image 8.2 - 3 Installed mid clamp



Image 8.2 - 2 Portrait installation



### CAUTION

#### Material damage due to incorrect mounting

Incorrectly fastened modules can fall and become damaged.

- Ensure the Clickstones click in securely.
- Ensure the modules are flush against both sides of the clamp.
- Observe and adhere to the recommended torque specifications.

## 9. Cable Management

A wide array of cable management options can be used with the Sigma Steel system. It is up to the installer to select and install cable management that best suits each installation.

As an example of a suitable cable management solution, Mounting Systems recommends cable ties which can be installed directly on the module frame and are  $cUL_{us}$  certified and UV-resistant.

## 10. Maintenance

When properly assembled, the Sigma I XL-ST is a reliable and trouble-free system and should require little in the way of ongoing maintenance or repair. Nevertheless, Mounting Systems recommends maintaining a regular inspection and maintenance schedule. Such a program can detect and address potential problems before they become serious and help ensure the system's excellent long-term durability and reliability.

The following procedure pertains only to the Sigma I XL-ST mounting system structure. Maintenance and repair of other PV system components should be carried out in accordance with the respective manufacturers' recommendations.

### 10.1 Inspection

The system should be visually inspected for obvious loose connections, missing components, modules which appear to have shifted, vegetation overgrowth, wind-blown debris and other indications of abnormality annually. Any problems detected at this time should be addressed and repaired as necessary.

### 10.2 Testing

After one year in service, it is a good practice to check the torque settings of a representative sample of system connections including module clamps and rail clamps. Do not exceed the recommended torque settings. If a disproportionate number of loose connections (more than 10% of connections) are found, it may be an indication of improper assembly and it may be necessary to take comprehensive corrective action.

A smaller sampling of connections can be tested annually thereafter. Mounting Systems recommends keeping records of the connections sampled each year and testing and, if necessary, adjusting previously untested connections in succeeding years. After all connections have been tested, sample sizes and test frequency can be reduced.

## 11. Appendix

### 11.1 List of evaluated and approved modules<sup>2</sup>

Manufacturer	Model
Canadian Solar	CS6P-XXX. Max coating thickness of 20 microns.
Hanwha Q Cells	Q Pro XXX. Max coating thickness of 20 microns.
Jinko	JKMXXXP-60.
Jinko	JKM310P-72.
SolarWorld	Sunmodule Plus SWXXX. Max coating thickness of 20 microns.
Yingli	YLXXX-29B. Max coating thickness of 20 microns.
Yingli	YLXXX-35B. Max coating thickness of 20 microns.

Note: XXX refers to the power class in watts (W) of the module.

<sup>2</sup> The Sigma Steel system is to be used only with modules on this list or with those which include the Sigma Steel system in their respective installation manuals.



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