

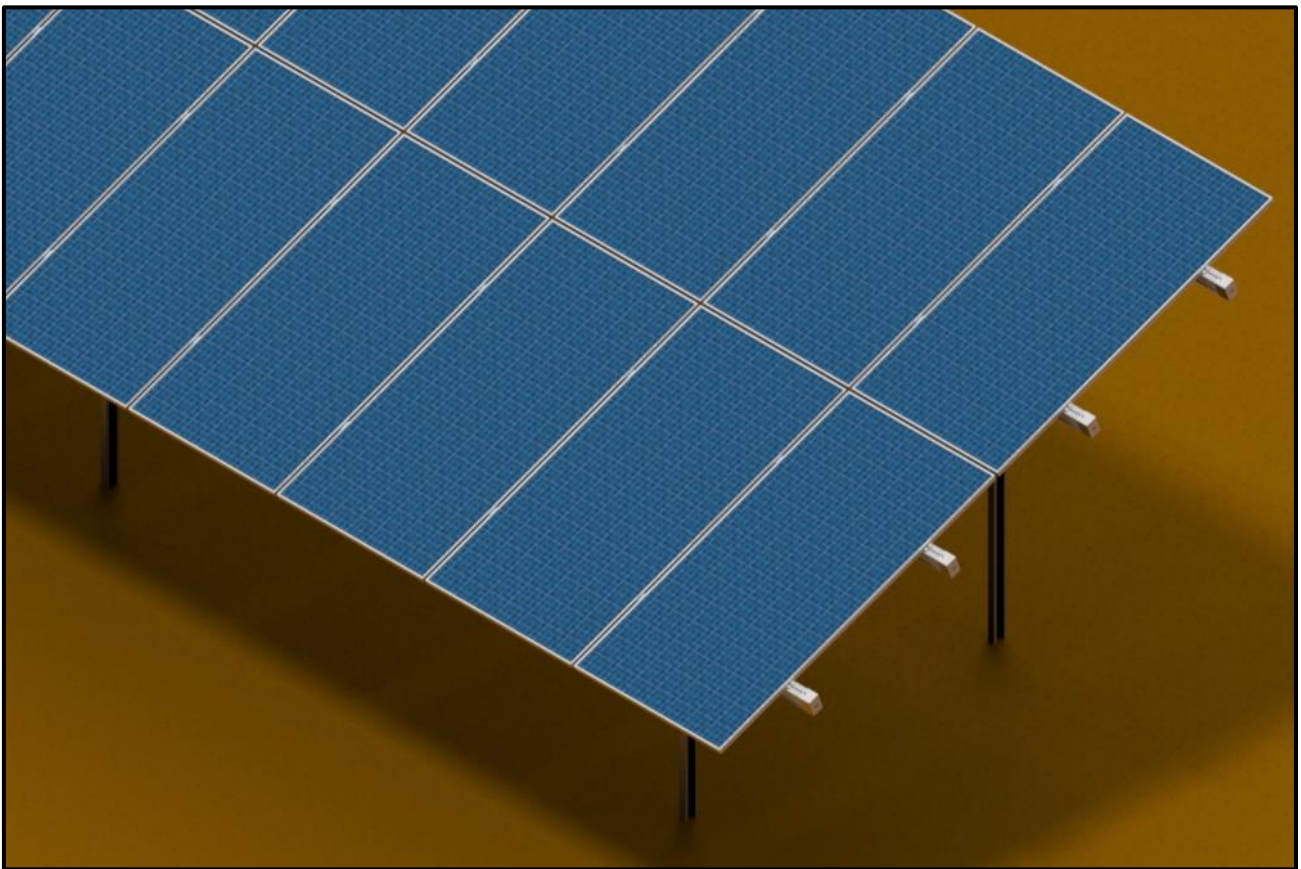
Installation Manual

IM_AXE_GM_ECO

Economical Tilted Ground Mounting System

For framed PV modules in portrait orientation

V0.01



Declaration

- Only the highest quality components are used in the mounting system to ensure a trouble-free operation of your solar power system. The following information explains the proper setup of the Axe Struct ground mounting system tilted in open fields.
- Any unique structural features must be documented so that the surrounding's unique features can be considered when planning the layout.
- Always fasten the bolted connection by turning the bolt head. Do not turn the nut, just hold it.

Contents

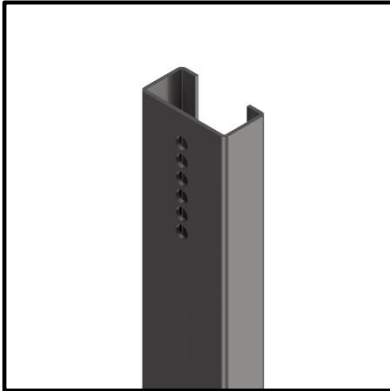
① Components	3
② Configuration options.....	11
③ Layout positioning	12
④ Foundation fixings	13
⑤ Foundation connection	15
⑥ Mounting rafters	17
⑦ Mounting rails	18
⑧ Joining rails.....	19
⑨ Bracing installation.....	20
⑩ PV module installation	22
⑪ End Caps.....	26
⑫ Maintenance.....	27
⑬ Liability.....	28

① Components

Pile/Post

AXE_GS_L_LC

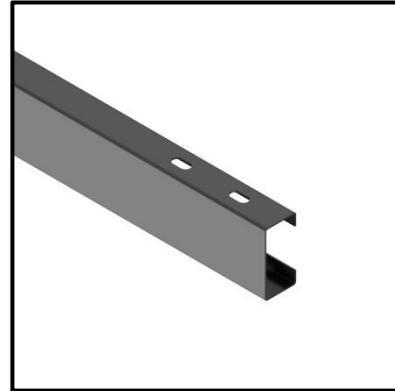
Upright support/Diagonal support



Rafter

AXE_GS_L_LC

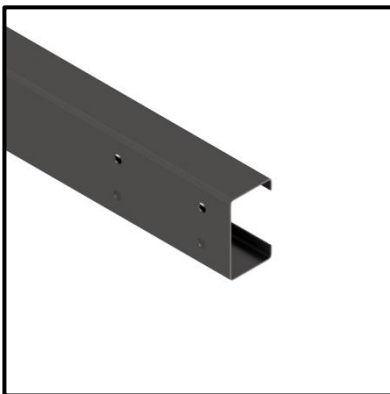
Support for rails



Steel Rail

AXE_GS_L_LC

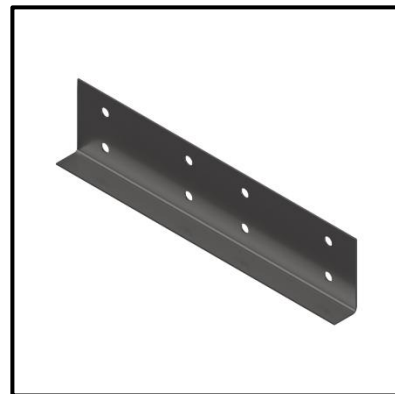
2.5m, 4.5m & 6m lengths



Extension

AXE_GS_EX_LC

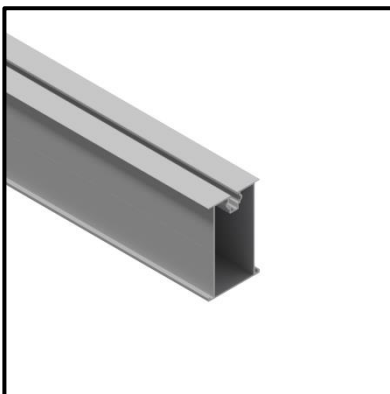
Joining Rail sections



Rail

AXE_AL_L_R_110_60

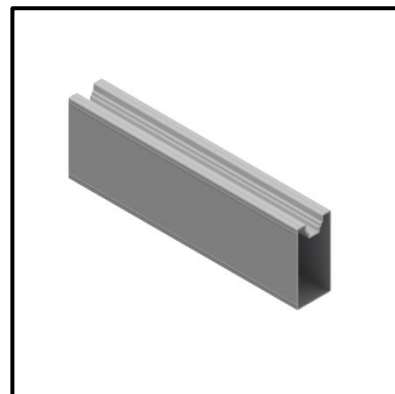
2.5m, 4.5m & 6m lengths



Extension

AXE_AL_EX_110_60

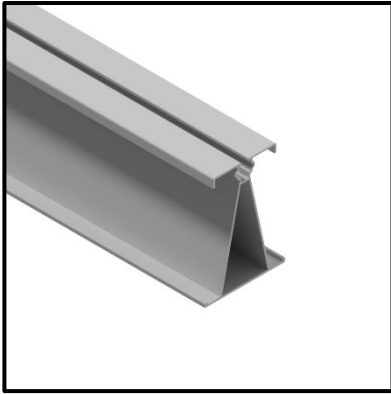
Joining Rail sections



Rail

AXE_AL_L_R_120_70

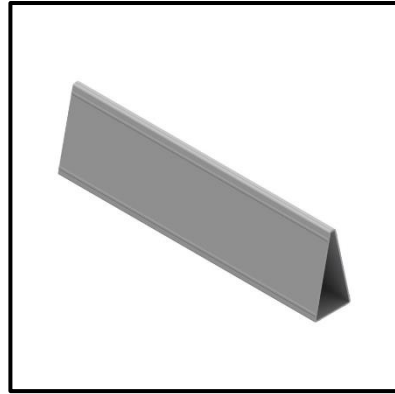
2.5m, 4.5m & 6m lengths



Extension

AXE_AL_EX_120_70

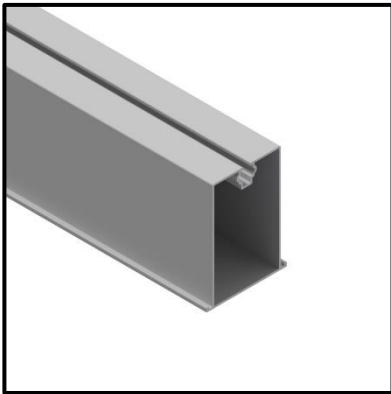
Joining Rail sections



Rail

AXE_AL_L_R_120_80

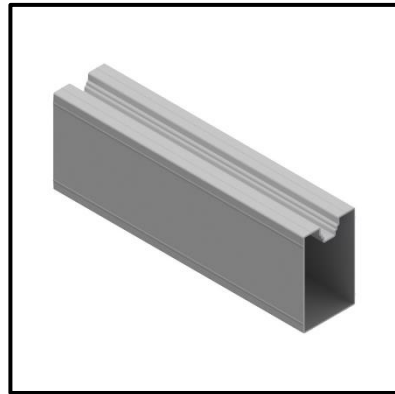
2.5m, 4.5m & 6m lengths



Extension

AXE_AL_EX_120_80

Joining Rail sections



Base Fix Bracket

AXE_GS_BR_BF_S_S

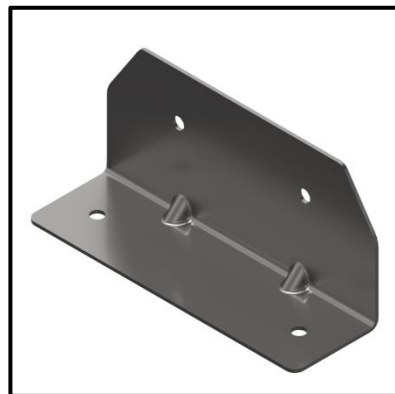
Post and base connection



Base Fix Bracket

AXE_GS_BR_BF_S_D

Post and base connection



Ground Screw

AXE_GS_GSP_W_T_1600_4

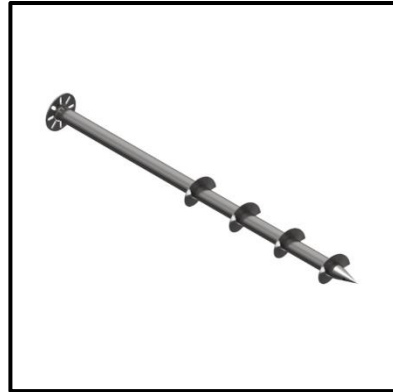
Structure foundation



Ground Screw

AXE_GS_GSP_W_F_1600_4

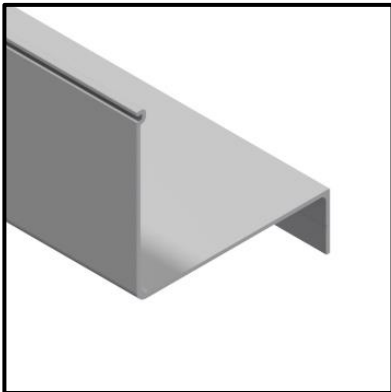
Structure foundation



Cable Tray Housing

AXE_AL_L_CT_H_60_70

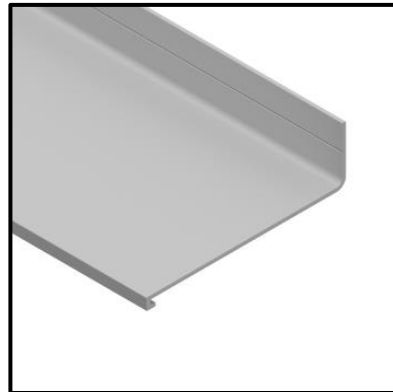
Cable management system



Cable Tray Cover

AXE_AL_L_CT_C_60_70

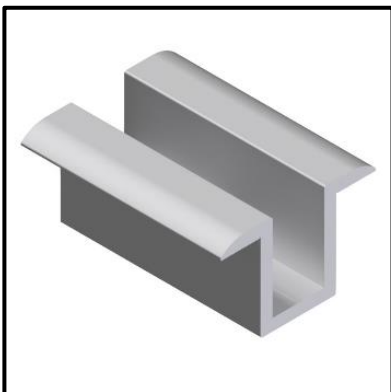
Cable management system



Mid Clamp

AXE_AL_CM_AP

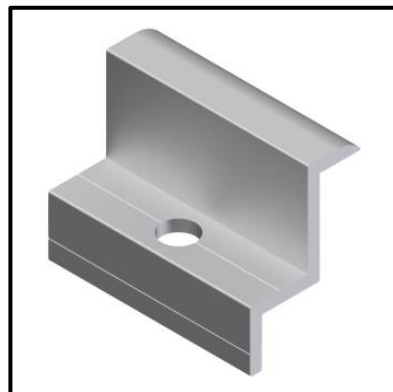
For PV modules with 30, 35 & 40mm frame heights



End Clamp

AXE_AL_CE_AP

For PV modules with 30, 35 & 40mm frame heights



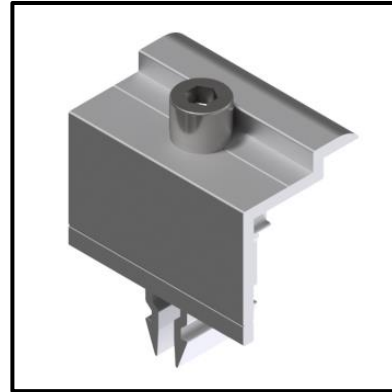
Mid Clamp
AXE_AL_CM_CF

For PV modules with 30mm and 35mm frame heights



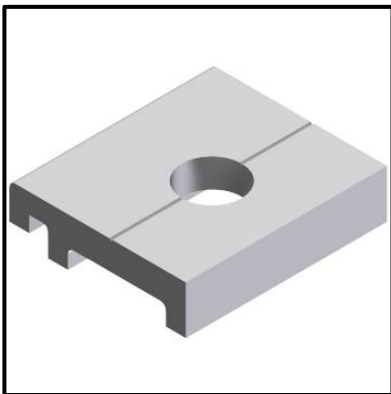
End Clamp
AXE_AL_CE_CF

For PV modules with 30mm and 35mm frame heights



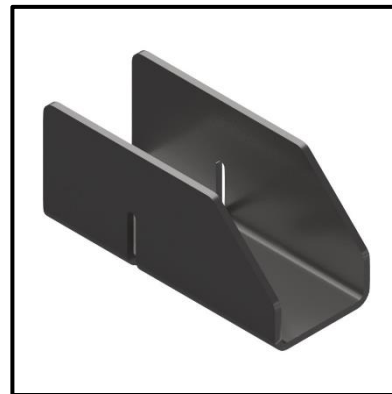
Rail Clip
AXE_AL_CP_GM

Rail and Rafter connection



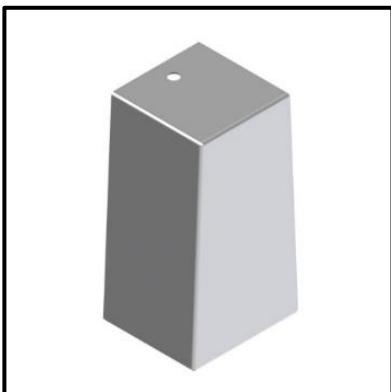
Wedge Clip
AXE_GS_CW_LC

Steel Rail and rafter connection



End Cap
AXE_AL_EC

Rounding of rails ends



Wire Rope Turn Buckle
AXE_GS_RW_B_10

Cable bracing connection



Wire Rope Length

AXE_GS_RW_L_8

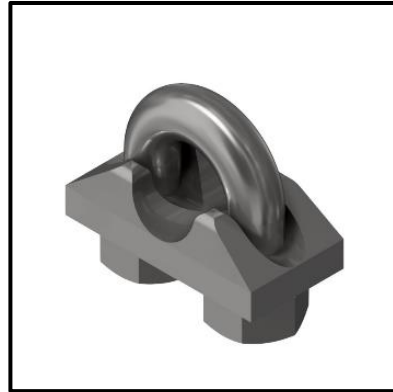
Cable bracing



Wire Rope Clamp

AXE_GS_RW_C_8

Cable bracing connection



Wire Rope Thimble

AXE_GS_RW_T_8

Cable bracing connection



Eye Nut

AXE_GS_NE_12

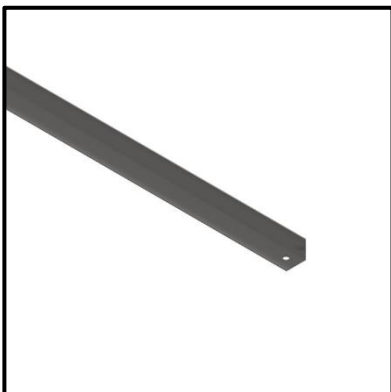
Cable bracing connection



Bracing

AXE_GS_L_AE_50_50_3

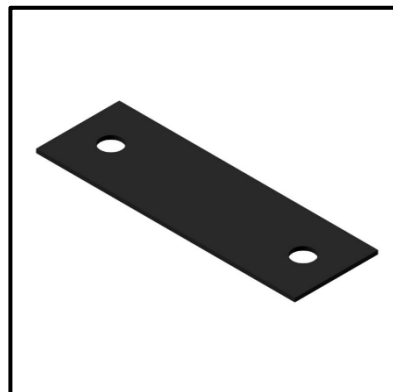
Equal angle bracing



Isolation Pad

AXE_PR_ISO_92/112

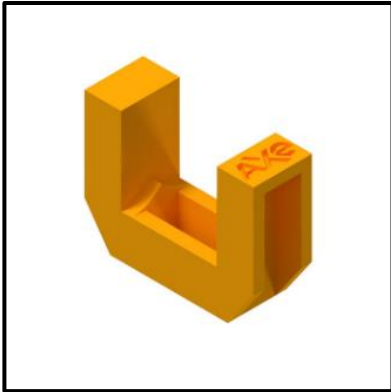
Isolation between Rail and Rafter



Nut Stopper

AXE_PP_NST_8

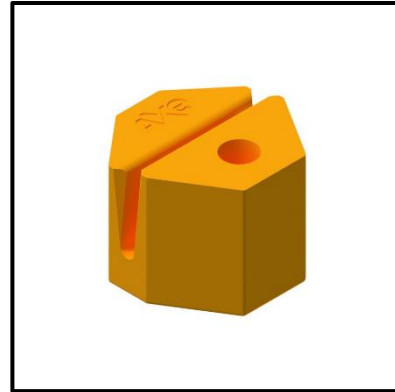
Guiding M8 Square nut into position



Nut Holder

AXE_PN_NHD_8

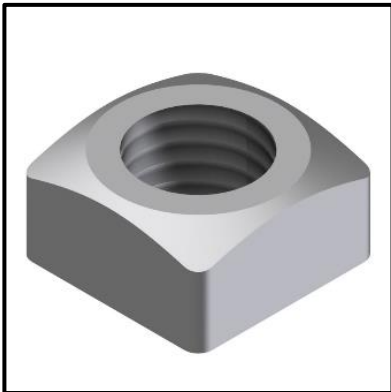
PV module and Steel Rail connection



Square Nut

AXE_SS_NSQ_8

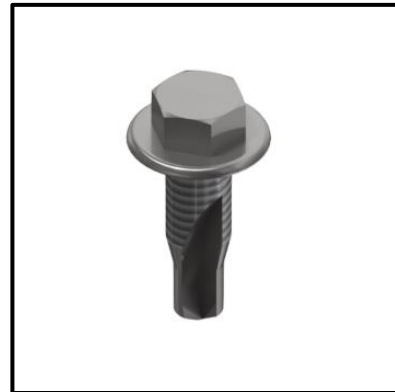
Rail and PV module connection



Self-Drilling Tek Screw

AXE_SP_ST_6.3_22

Rail extension connection



Cap Screw Hexagon

AXE_SS_CS_8

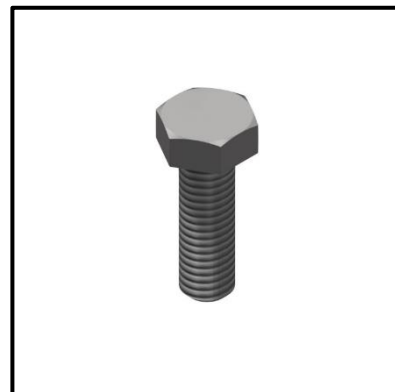
PV module connection



Bolt Hexagon

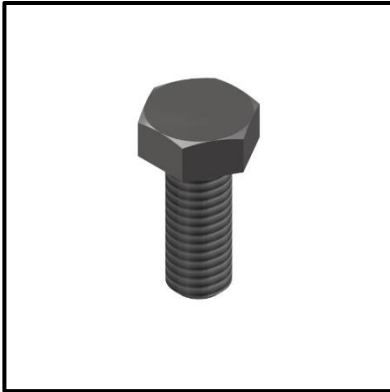
AXE_SS_BH_10

Rail and rafter connection



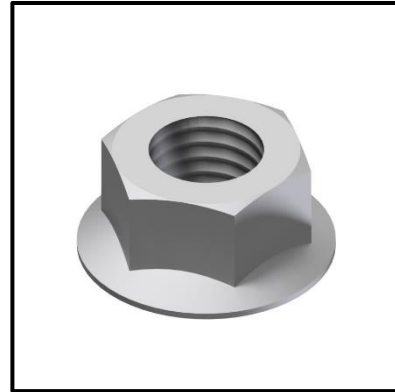
Bolt Hexagon
AXE_GS_BH_12

Pile/Post and Rafter connection



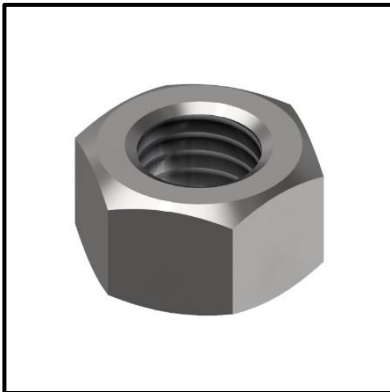
Hex Flange Nut
AXE_SS_NHF_10

Rail and rafter connection



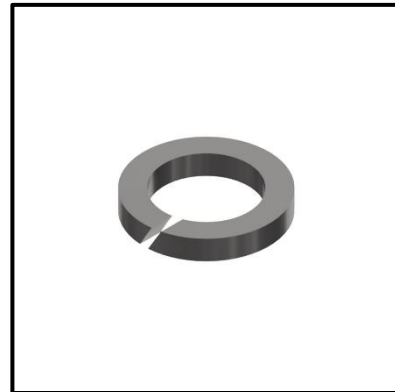
Hex Nut
AXE_GS_NH_12

Pile/Post and Rafter connection



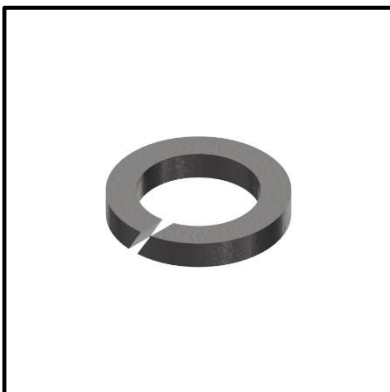
Spring Washer
AXE_SS_WS_8

PV module connections



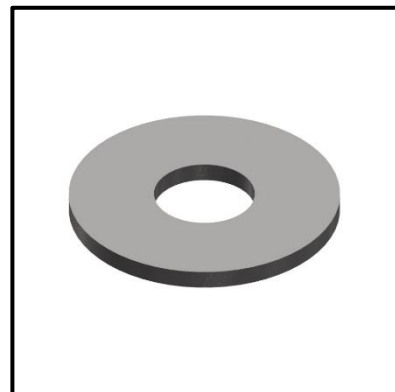
Spring Washer
AXE_GS_WS_10/12

Steel Rail/Post and Rafter connection



Fender Washer
AXE_GS_WF_12

Steel Rail and Rafter connection



Plain Washer
 AXE_GS_WP_12

Pile/Post and Rafter connection



Cable Clip
 AXE_SS_CFC

Cable Management system



Torque settings

The specified settings below are assumed to have a dry application. Should a lubrication agent or anti-seizing be used, 80% of the below-listed values would apply. Fastening should cease when aluminium sections start to deform visually.

Size	Stainless Steel (N·m)	Galvanized Grade 8.8
M8	18 N·m	N/A
M10	38 N·m	N/A
M12	60 N·m	93 N·m
M16	150 N·m	230 N·m
M20	300 N·m	464 N·m
M24	N/A	798 N·m

Seizing (Galling) Prevention

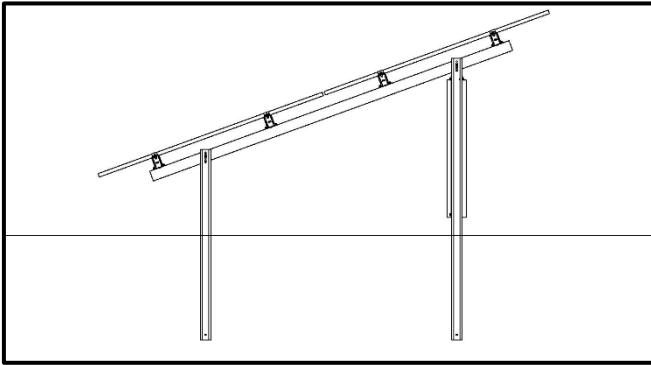
Copper slip paste should be applied to all threaded connections, specifically stainless-steel fasteners. This will prevent fasteners from seizing and promote good practice. A further step to prevent seizing is to tighten fasteners at low rpm, without interruptions and apply steady pressure.

② Configuration options

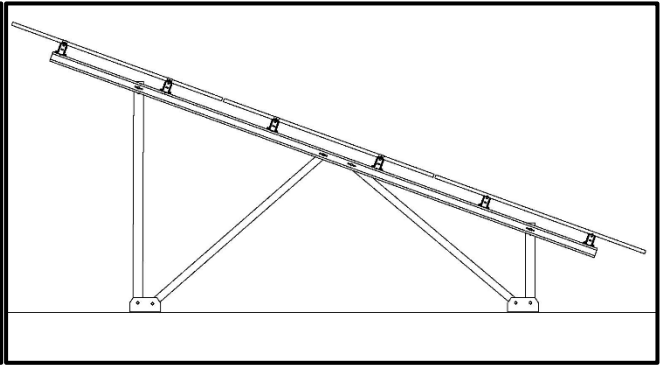
Ground mounts are offered in the following configurations.

- Two panels in Portrait (2P)
- Two panels in Portrait, single vertical post (2P)
- Three panels in Portrait (3P)

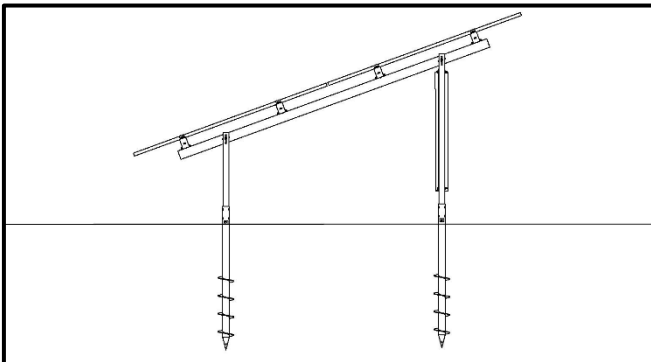
Driven or embedded (2P or 3P)



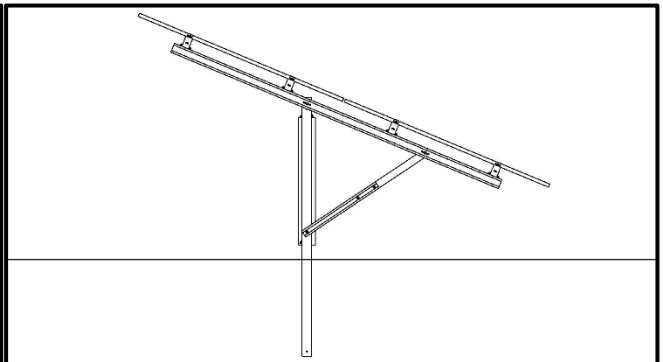
Base connector (2P or 3P)



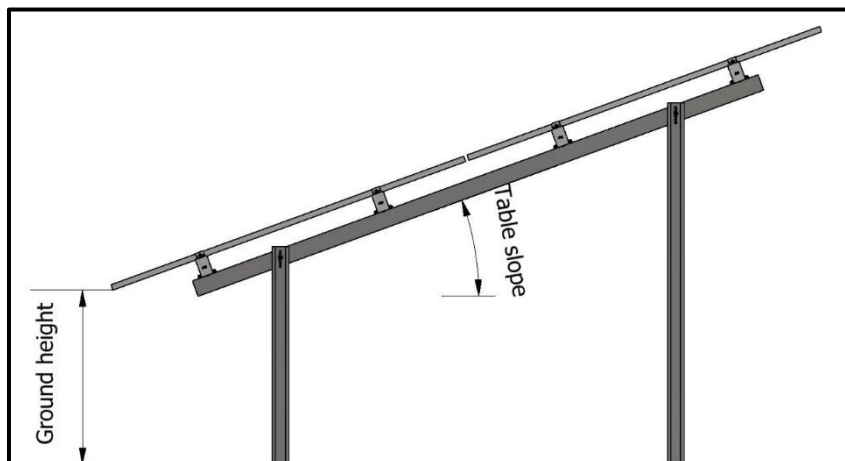
Ground Screw (2P or 3P)



Driven or embedded single post (2P)



To maintain continuity throughout this document, all images are based on the 2P configuration. Please refer to the project-specific layout drawings for foundation specifications and Post/Pile spacing details.

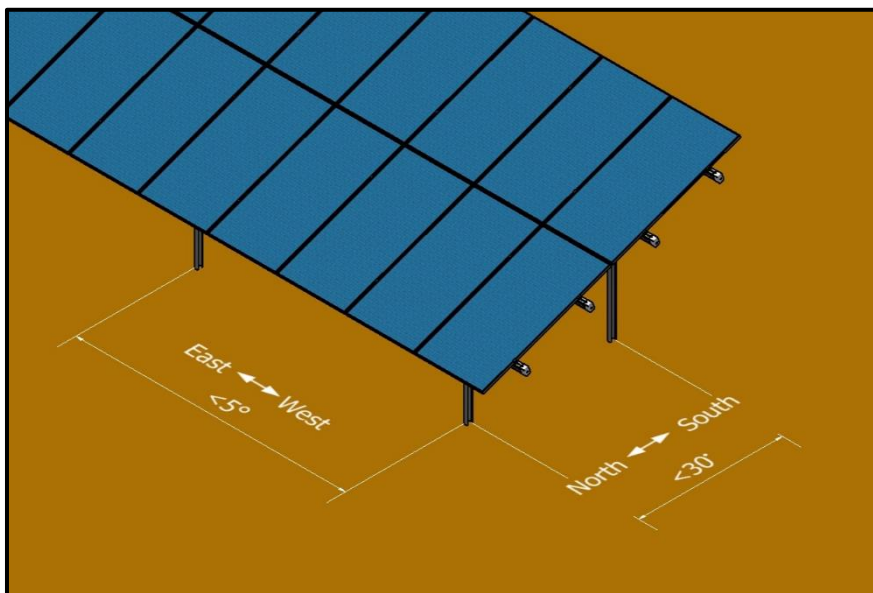


③ Layout positioning

The spacing between piles, as well as the size of the structural members, is determined by structural analysis. The outcome of the structural analysis depends on factors such as the site location (altitude and wind speed), desired layout (panel/string sizes or space), table slope, front panel edge ground height, and method of installation. Providing incorrect information will result in an incorrect structure.

Ensure that the correct layout drawing provided by Axe Struct is used for your site-specific structure. The layout drawing illustrates the reaction forces, side, back, and top views of the table. These drawings also indicate the site conditions and the sections as determined by the structural analysis. Lengthening or shortening the tables, changing the panel type, or altering the tilt without consultation can result in the failure of the structure.

The terrain geography must be conveyed to the designer to maintain the requested table slope and PV module ground clearance height. The east–west terrain slope must be within a 5° tolerance, and the north–south terrain slope must be lower than 30° .



④ Foundation fixings

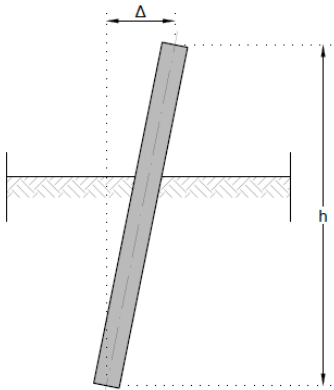
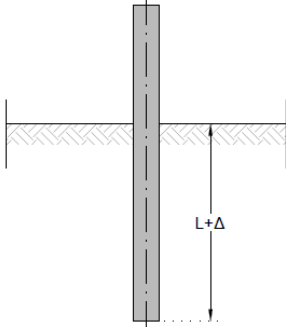
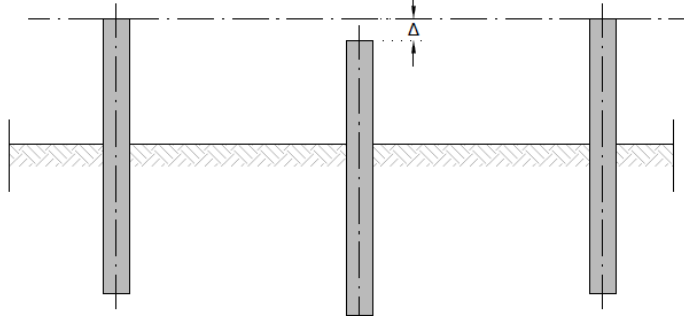
Mark the positions of the pile locations. The open side direction of the pile is determined through the layout view, with the opening typically facing west. A frame guide rail can be used to ensure the required tolerances are met and to guarantee the perpendicular positioning of the piles.

Recommendation

- Ensure the open side of the pile channel is facing a direction that accommodates the rafter orientation. The holes in the rafter that accommodate the rails must face upwards, and the overhang of the rafters must comply with the dimensions specified in the layout drawing.
- If unexpected obstacles obstruct pile driving operations, the target depth must be pre-drilled, filled in layers with compressed concrete of strength C16/20, and compacted before driving the pile into position.

Tolerances to consider when driving in Piles are as follows (measured at ground level):

Description	Depiction	Tolerance
Individual pile position relative to the reference point (RP)		$\Delta 1 = \pm 10\text{mm}$ $\Delta 2 = \pm 10\text{mm}$
Individual pile spacing relative to the adjacent piles		$\Delta = \pm 10\text{mm}$
General pile alignment relative to the reference line (RL)		$\Delta = \pm 10\text{mm}$
Overall table length and North-South spacing		$\Delta 1 = \pm 20\text{mm}$ $\Delta 2 = \pm 10\text{mm}$

Individual pile inclination		$\Delta = h/200$
Individual pile depth		$\Delta = \pm 100\text{mm}$
Individual pile level relevant to the adjacent piles		$\Delta = \pm 20\text{mm}$

The images in the above table are based on pile driving; however, these principles can also be applied to posts that are cast into the concrete.

⑤ Foundation connection

Different fixation methods can be used on the ground mount, and the structure will be designed accordingly. The following sections outline essential guidelines for each method.

Driven Channel:

A suitable hammer machine is used to drive the piles into the ground, typically to a depth of 1.4 meters. The depth of 1.4 meters is commonly used for standard installations, although the exact depth may vary depending on the specific project requirements and the type of soil.

After the pile has been driven into the desired position, it is important to protect the top of the ramming profile from any potential surface damage caused by the pile driving activity. To prevent damage and corrosion, the top of the ramming profile should be coated with a protective layer of paint. The paint should cover approximately 3 cm of the top of the pile profile to create a durable protective barrier.

Channel embedded in concrete:

Before embedding the channel in concrete, ensure that the hole in the ground is free of loose dirt at the bottom. The diameter of the hole, typically 1.0 meters deep, must be determined through a physical pull test to ensure it can resist the forces outlined in the layout drawings. This ensures the pile will remain securely anchored and able to withstand the structural loads it will encounter.

It is highly recommended that each pile be integrated with the rebar reinforcement for added stability and strength. To achieve this, use the drilled holes through the pile to insert securing rods. These rods should be placed through the holes to provide a strong bond between the pile and the surrounding concrete, enhancing the pile's resistance to forces that could otherwise cause shifting or instability.

Prior to casting the concrete, the piles should be positioned accurately within the tolerances specified in Section 4 to maintain alignment and ensure structural integrity. After the concrete is poured into the hole, it is essential to use a vibrator to remove air pockets and ensure the concrete fully surrounds the pile, achieving maximum strength and stability once cured.

Ground Screw foundation:

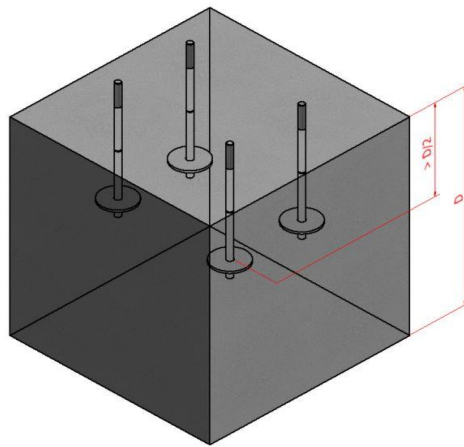
Conduct a thorough site survey to determine the soil type, ground conditions. This will determine the appropriate ground screw type and dimensions. Use the layout drawings to mark the precise locations for each ground screw. The locations should be clearly marked and checked for accuracy before beginning installation.

Use a ground screw driving machine to rotate and screw the pile into the ground. This machine should apply sufficient torque to ensure the screw penetrates the soil evenly and to the required depth. As the screw is driven into the ground, ensure it remains straight and vertical. Check that the ground screws are installed correctly, at the correct depth, and securely anchored.

Concrete foundation:

Mark the positions of the foundation locations according to the layout drawings. Prepare the designated areas for the concrete bases, ensuring proper compaction as shown in the layout drawings. The concrete foundations must be constructed on a 150mm thick layer of Class G5 material, compacted to 95% of the MOD AASHTO standard. The previously mentioned material layer should be placed on in-situ material compacted to 93% of the MOD AASHTO standard.

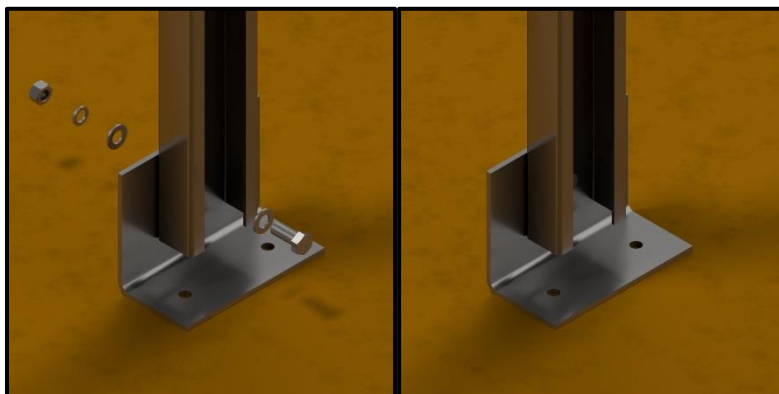
The concrete foundations are designed for a minimum strength of 30 MPa. Before applying any tension to the bolts, allow 7 days for curing. Use a guide plate, jig, or dowels to position the threaded rods correctly in the concrete bases. The threaded rods should be rated to withstand the reaction forces specified in the project-specific layout drawings. The threaded rods should be embedded at least halfway ($D/2$) into the foundation depth in the concrete.



Recommendation

- We strongly advise pre-casting the M12 threaded rods into the concrete base, using a bolted washer with an outer diameter (OD) of 80 mm and a thickness of 4 mm. This washer should be positioned below the midpoint of the base depth. As an alternative, at your own risk, chemical anchors may be used. In such cases, the specifications and installation methods provided by the supplier must be strictly followed.

The Posts are connected to the Single and Double Base Fix Brackets using M12x30 Hex Bolts, M12 Spring Washers, 2x M12 Plain Washers and M12 Hex Nuts. Torque M12 Hex Bolt to 93 N-m.



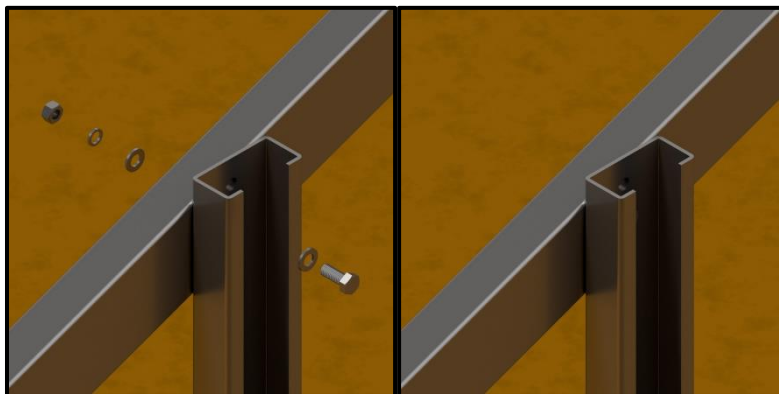
⑥ Mounting rafters

The Rafters are connected to the Front and Back Piles using M12x30 Hex Bolts, M12 Spring Washers, 2x M12 Plain Washers, and M12 Hex Nuts.

The M12x30 Hex Bolts, M12 Spring Washers, M12 Plain Washers, and M12 Hex Nuts connections are torqued to 93 N-m once all the Rafters have been aligned on a single table. This alignment must be done for both the bottom and top end of the Rafters in a vertical and horizontal plane.

Recommendation

- Use the pre-drilled holes and slots on the rafters to connect the first and last rafters on each table. Once the outer rafters of each table are assembled, stretch a gut line between them. The Posts/Piles in the middle of the table can then be aligned with the two outer Posts/Piles following the gut line as a reference.

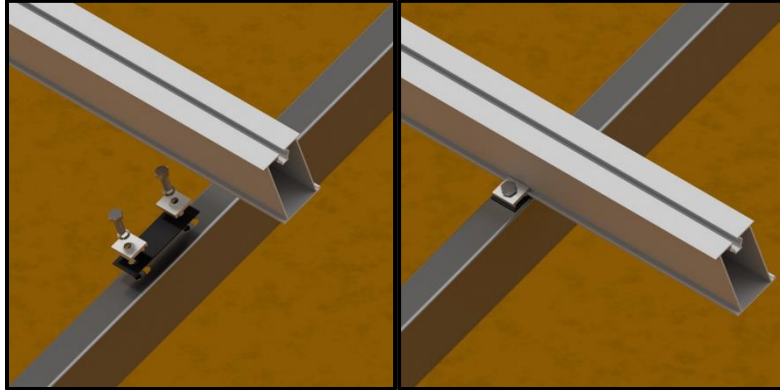


Follow a similar process to connect the Diagonal Supports to the Rafter and Base Fix Bracket using M12x30 Hex Bolts, M12 Spring Washers, M12 Plain Washers, and M12 Hex Nuts. This will be indicated on the layout drawing if required.

⑦ Mounting rails

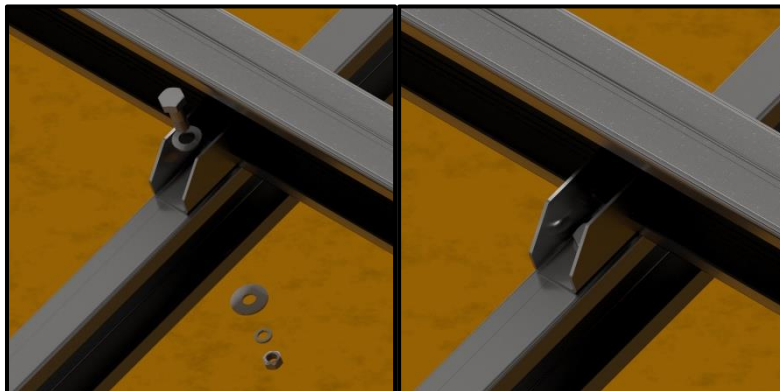
Rail Clips:

Align the Isolation Pad with the slotted holes in the Rafter, position the Rail on top of the Isolation Pad. Connect the Rail Clips to the Rail and line up with slots on the Rafter. Use M10x30 Hex Bolts, M10 Spring Washers and M10 Hex Flange Nuts to secure the Rail to the Rafter. Torque M10 Hex Bolt to 38 N·m.

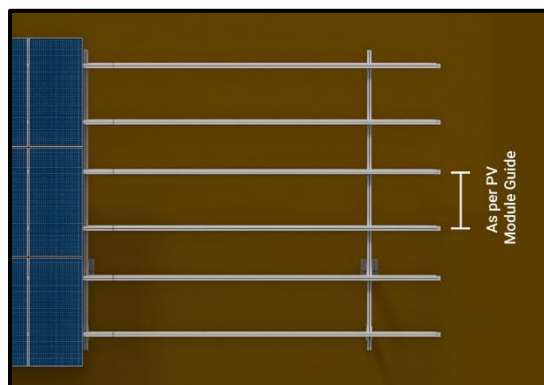


Wedge Clip:

Align the Wedge Clip with the slotted holes in the Rafter and over the Rail lip. Use M12x30 Hex Bolts, M12 Spring Washers, 2x M12 Plain Washer, M12 Fender Washer and M12 Hex Nuts to secure the Rail to the Rafter. Torque M12 Hex Bolt to 93 N·m.



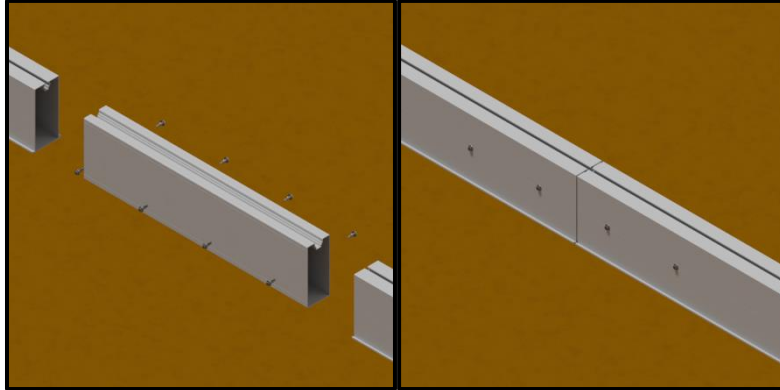
The Rail spacing is dependent on the dimensions of the PV module used. PV module installation manuals indicate supporting requirements. Please refer to the project-specific layout drawings for the Rail configuration. Standard Rail lengths of 2.5 m, 4.5 m, and 6.0 m will be used for the configuration of the top structure.



⑧ Joining rails

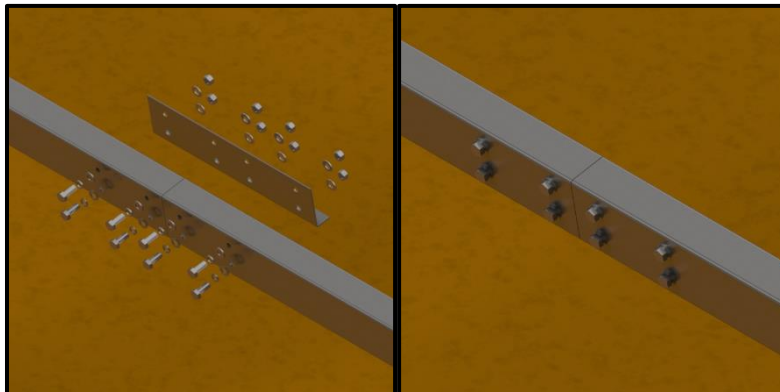
Aluminium rail:

Mark the midpoint of the Rail Extension, then slide the Rail Extension halfway into the adjoining Rails. Secure the connection by using eight M6.3 Self-Drilling Tek Screws to tighten it.



Steel rail:

Secure the connection by using M12x30 Hex Bolts, M12 Spring Washers, 2x M12 Plain Washer and M12 Hex Nuts. Torque M12 Hex Bolt to 93 N·m.



⑨ Bracing installation

Two different bracing options are available.

- Angle Bracing
- Bracing Cables

The bracing of a structure is designed to prevent movement or swaying in a single direction. Bracing members work in tension to limit movement along the length of the table (the direction of the rails).

The appropriate bracing option will be selected based on the structure and site conditions. The bracing is connected to the back posts/piles of the structure at the locations specified in the layout drawings.

A suitable position for securing the Brace is 200mm from the ground on back Post/Pile and 200mm from the top of the adjacent back Post/Pile. The same applies in reverse to form an "X" shape. Holes for the braces should be drilled on-site.

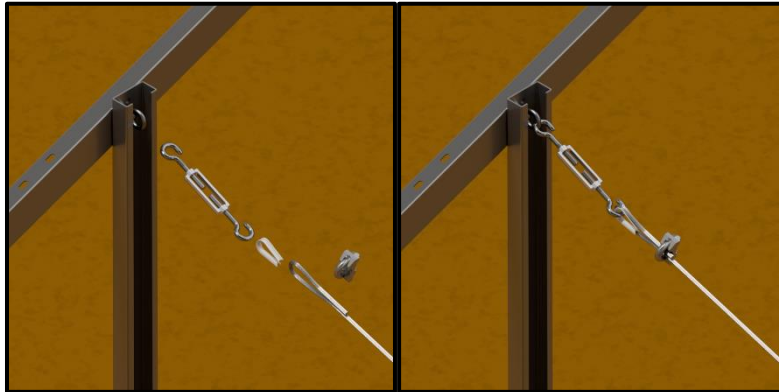
Angle Bracing:

Use M12x30 Hex Bolts, M12 Spring Washers, 2x M12 Plain Washers and M12 Hex Nuts to secure the Bracing angle to the Post/Pile. Torque M12 Hex Bolt to 93 N·m.

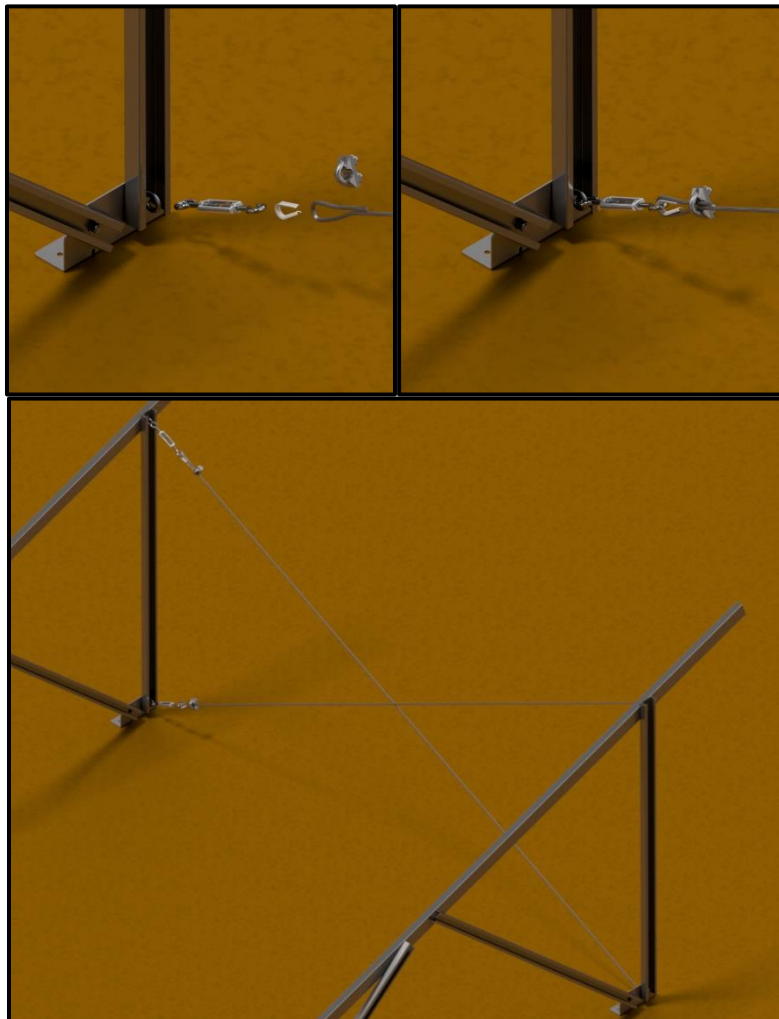


Bracing Cables:

Connect the M12 Eye Nut to the Rafter using M12x130 Hex Bolts, 2x M12 Plain Washers, and M12 Spring Washer. Prepare the end of the Wire Rope using the Wire Rope Thimble and Wire Rope Clamp and connect the Wire Rope to the Eye Nut using the Wire Rope Turn Buckle. Torque M12 Hex Bolt to 93 N·m.



Connect the M12 Eye Nut to the bottom of the Post/Pile using M12x30 Hex Bolts, 2x M12 Plain Washers, and M12 Spring Washers. Connect the Wire Rope to the Eye Nut using the Wire Rope Thimble and Wire Rope Clamp.



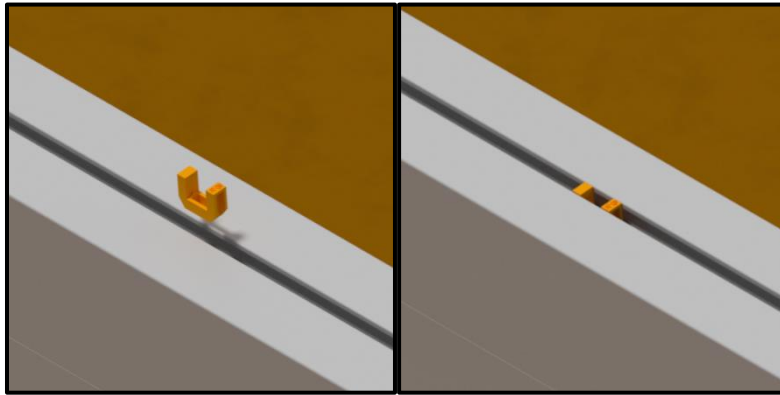
Bracing Delivery

- The equal angle sections will be supplied in 6m lengths and should be cut on site. The Cable should also be cut on site.

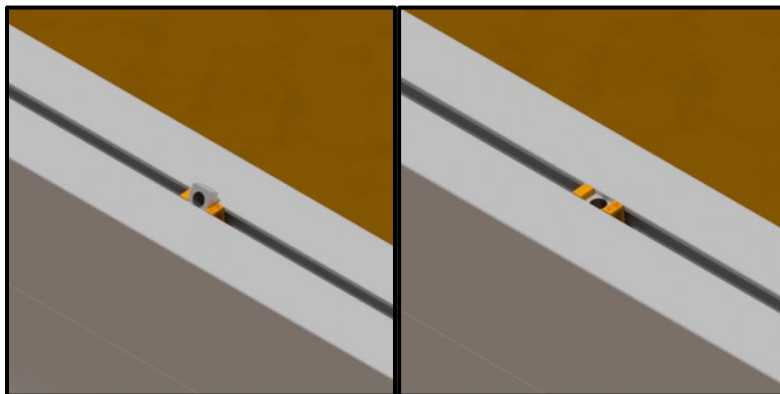
⑩ PV module installation

Nut Stopper:

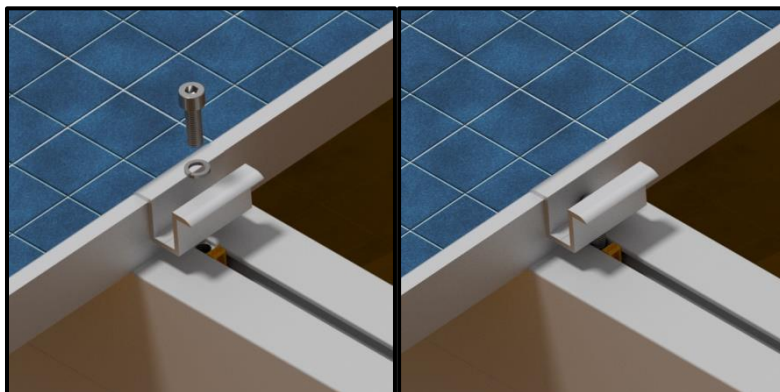
Insert Nut Stoppers into the Rail gap where the installation of PV module Clamps will be.



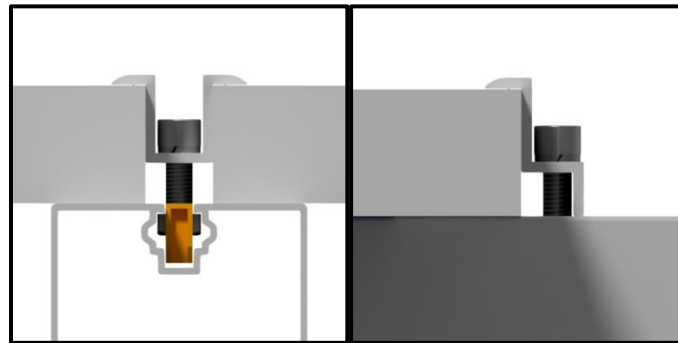
Position an M8 Square Nut at each Nut Stopper. Slide M8 Square Nut at an angle into Rail cavity so that it falls vertically with flat side facing upwards.



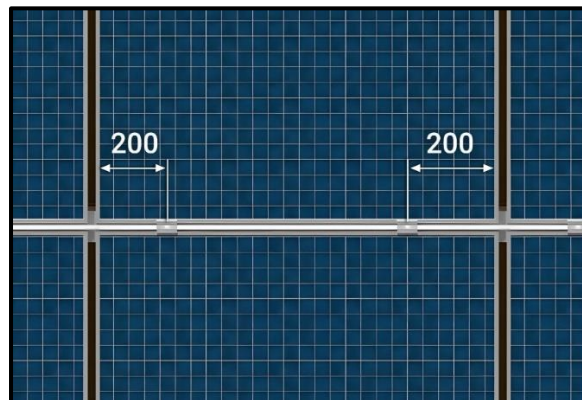
PV modules should be laid onto the Rails in a portrait orientation, ensuring each module is supported by two Rail lengths. Install PV module clamps at four locations: one Clamp on each opposing long side and two Clamps on the short sides. These Clamps secure the PV modules firmly to the Rails. Tighten the M8 Hex-Cap Screws to a torque of 18 N·m to ensure proper fastening and stability.



Mid Clamps are installed between two adjacent PV modules to secure them, while End Clamps are used at the ends of each row of PV modules. Ensure all clamps are mounted flush against the sides of the PV modules for a secure and stable fit. Proper placement of clamps helps maintain alignment and structural integrity throughout the installation.

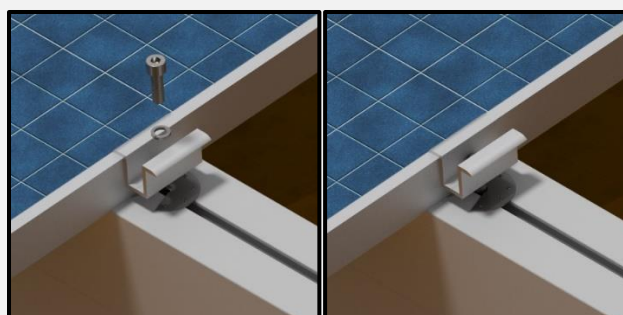


When installing Mid Clamps on the short sides of PV modules, ensure their centres are positioned ± 200 mm from the module's side edges.



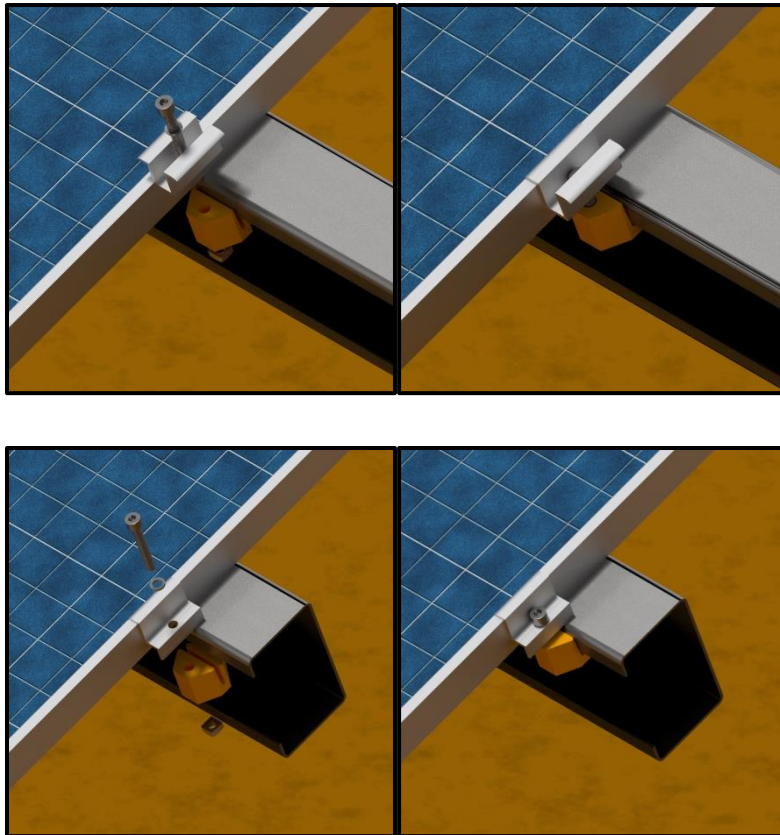
Earthing insurance

To ensure effective earthing of photovoltaic (PV) modules and maintain electrical continuity, the anodised layer on the module frames must be breached using Earth Plates. Begin by positioning the Nut Stopper and Square Nut in the Rail cavity to match the PV module's clamping configuration. Next, place the Earth Plate on the rail with its long lip securely seated in the rail cavity behind the Nut Stopper. Slightly lift the PV module and slide the Earth Plate along the rail until the short lip contacts the side of the module. Lower the module onto the Earth Plate so the spikes pierce the anodised layer, aligning the Square Nut with the central hole of the Earth Plate. This process ensures a secure connection and reliable earthing for the system.



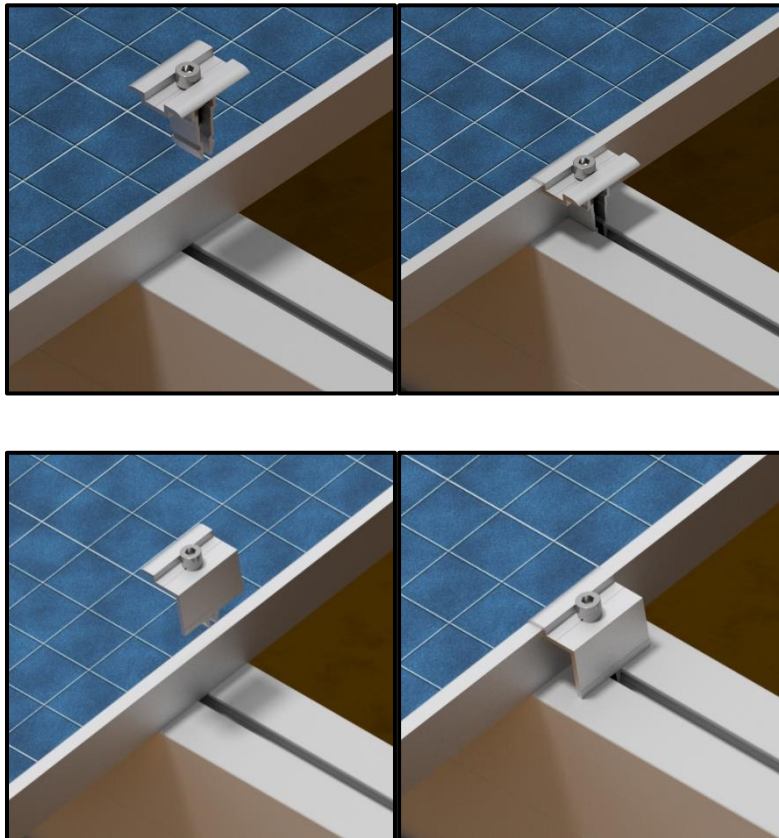
Nut Holder:

With the PV module in position on the Steel Rail, position the Nut Holder over the Rail lip and in line with the panel edge connect the Mid/End Clamp to the Nut Holder using an M8 Hex Cap Screw, M8 Spring Washer and M8 Square Nut.



Click Fix:

With the M8 Hex Cap Screw already protruding, insert the Mid Clamp Click Fix between adjacent panels by pushing the pegs into the Rail slot. Ensure the clamp is securely seated in the Rail before positioning the panels flush against the clamp. Tighten the M8 Hex Cap Screw to a torque of 18 N·m to secure the panels in place. Avoid repeatedly inserting and removing the Click Fix components to prevent damage or wear.



Clamps and Fasteners

It is essential to ensure that the appropriate clamps and fasteners are supplied according to the height of the PV module.

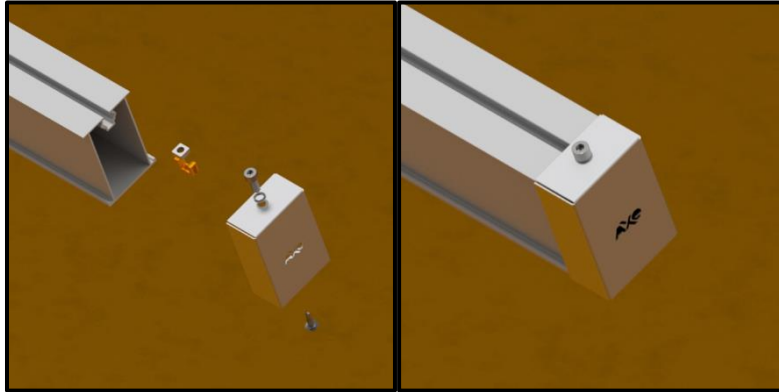
Module height (mm)	End Clamps	Fasteners (Mid & End Clamps)
30	AXE_AL_CE_AP_30	M8x25 Hex Cap Screws
35	AXE_AL_CE_AP_35	M8x30 Hex Cap Screws
40	AXE_AL_CE_AP_40	M8x35 Hex Cap Screws

When using Nut Holders the following will apply.

30	AXE_AL_CE_AP_30	M8x50 Hex Cap Screws
35	AXE_AL_CE_AP_35	M8x55 Hex Cap Screws
40	AXE_AL_CE_AP_40	M8x60 Hex Cap Screws

⑪ End Caps

To achieve a neat finish, slide the End Caps over the ends of the Rails. Position the Nut Stopper and Square Nut configuration near the end of the Rail. Then, slide the End Cap into place and tighten it using an M8x20 Hex Cap Screw. For added security, an M6.3 Self-Drilling Tek Screw can be installed at the bottom of the End Cap.



⑫ Maintenance

The products are to be inspected annually in the form of a visual inspection of the whole installation. Axe Struct must be notified of any first appearances of rust and abnormal deformations.

Annual spot checks are to be done on fasteners to ensure that the minimum required torque moment specified in this Manual is met.

Zinc paint touch-ups must be done where galvanising layers have been damaged.

Cleaning of the product must be done with water with a pH between 6 and 10, and without chemicals.

⑬ Liability

Axe Struct can accept no liability for damage arising due to improper use, installation, operation or maintenance. Liability is further excluded if Axe Struct is not at fault due to gross negligence or intent.

The text and images in this Installation Manual correspond to the state of the art upon printing. Subject to change.