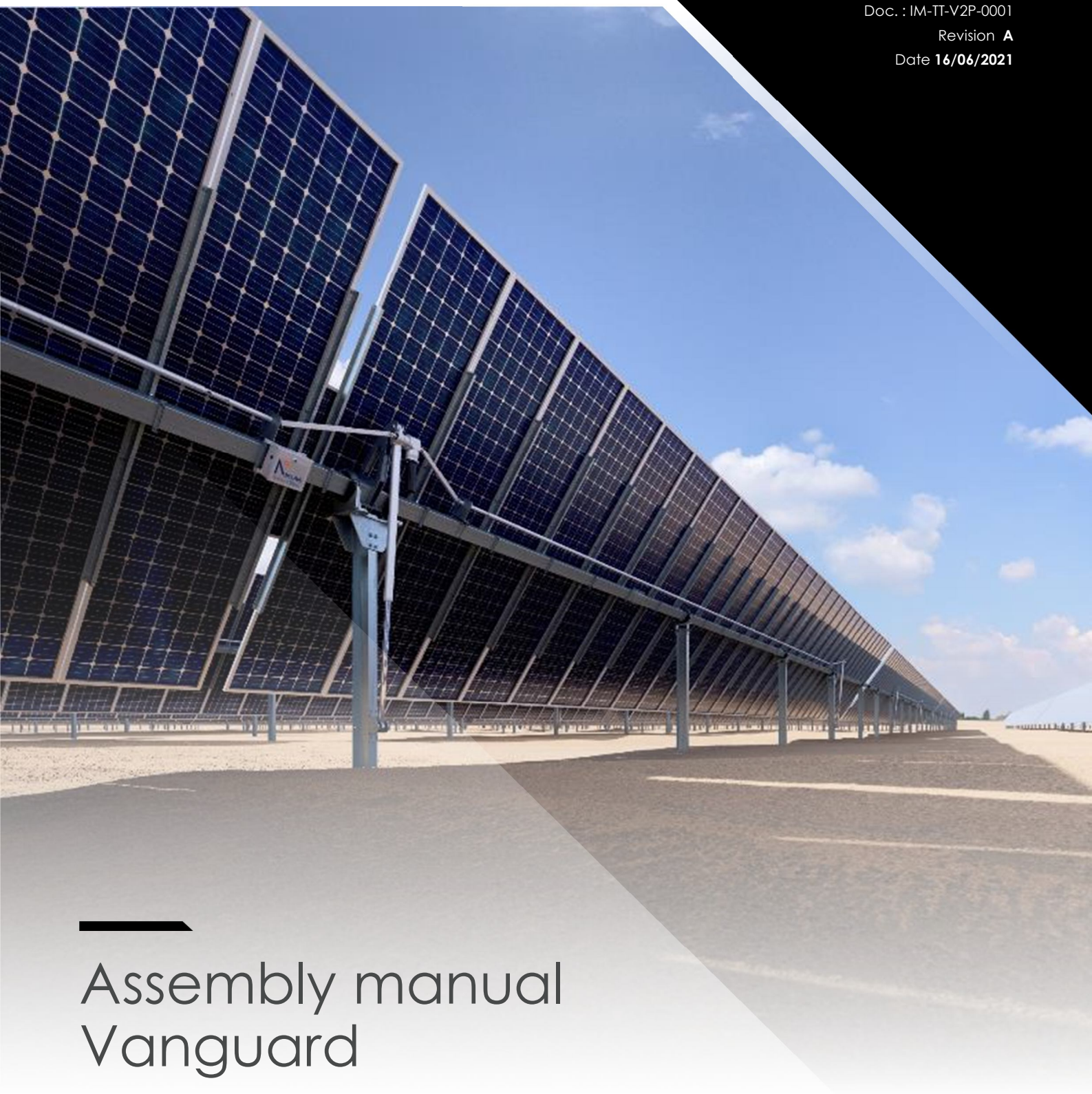
TrinaTracker

PRODUCT SPECIFICATION

Doc. : IM-TT-V2P-0001
Revision **A**
Date **16/06/2021**



Assembly manual Vanguard

STANDARD MANUAL

REVISION CONTROL

REV	DATE (dd/mm/aa)	DESCRIPTION	ELABORATED	REVISED	APROVED
1	04/04/20	INITIAL DOCUMENT	VVE	LGA	AVF
2	09/03/2021	TECHNICAL UPDATE	VVE	LGA	AVF
3	26/03/2021	NEW LEVER & NEW SQUARE JOINING CLAMP	VVE	LGA	AVF
4					

INDEX

1 LIST OF TOOLS AND MACHINERY

All the machinery and tools are commonly available but are not provided by Trina Solar.

1.1. Auxiliary machinery

- Pile driving: **DRIVING MACHINE (PILE DRIVER)** with **DRIVING TOOLS** (recommended power > 1.000J). Consult with the entity that will carry out the pile driving work, information presented in the geotechnical report and site conditions to determine all pile driving equipment needs such as drill sets or additional machinery.
- Material unloading: **TELEHANDLER** or similar is required. An **UNLOADING RAMP** is recommended.
- For staging and site distribution: **TELEHANDLER** with **UNLOADING TOOLS** (tie clips, unloading beams, slings, …) or similar machinery such as hoist trucks.

1.2. Site survey equipment

- A minimum of **GPS, TOTAL STATION** and a **TOPOGRAPHICAL LEVEL** is needed.

1.3. Tools

- For tracker alignment, leveling and mechanical assembly, the following tools are necessary: **TORQUE WRENCH SET** (70 Nm / 51,6 ft. lb. to 500 Nm / 368,8 ft. lb, torque, 20 Nm / 14,8 ft. lb. to 80 Nm / 59,0 ft. lb. torque and 6 Nm / 4,4 ft. lb. to 50 Nm / 36,9 ft. lb. torque) preferably digital, **DIFFERENT CALIBER HEAD WRENCH SET, ROPE, DUAL GRADE ROTARY LEVEL, GNOMETER, LASER POINTER and TARGET, MEASURING TAPE, FIXED and RATCHET WRENCHES, NYLON HAMMER, MULTIMETER, ELECTRICIAN'S SCREWDRIVERS.**

  RIVET GUN for BLIND RIVETS (U reinforcement Purlin), **RIVET GUN** for **PIN-COLLAR RIVETS** (depending on the module's fixation system)

  (*) The rivet guns shall be used only in the specific case that Purlin set does not come pre-assembled from supplier.

1.4. Auxiliary gear

- For the pre-assembly of certain sets of pieces (double bearing supports, transmission bar sets, …), assembly tables are recommended. For the pre-assembly of the torque tube configurations, easels (at a height of 1.00 m – 1.20 m) is recommended. Ensure the platforms are structurally sound and can bear the weight and loads of the pre-assembly.

- For high installation, stairs or scaffolding are recommended.

(*) All the auxiliary machinery, tools and auxiliary gear previously described must be inspected and verified that they are in good conditions for their use.

2 TORQUE TIGHTENING VALUES

Following table shows torque tightening values to apply in VANGUARD Tracker bolted joints.

REFERENCE	Tightening Torque (Nm/ft. lb.)
M4 (Purlin joint & modules for grounding and bonding)	4 / 2.9
M6 (purlin joint & modules)	(*) 10 / 7.3
M6 (rigid joint)	10 / 7.3
M6 (TCU SS)	4.4 / 3.2
M8 (purlin joint & module joint)	(*) 12 / 8.9
M8 (joints without contact - blocking plates)	17 / 12.5
M10 (TCU SP)	1.7 / 1.2
M10 (screwed joints for purlin-tube)	40 / 22
M10 (U bolts)	25 / 18.4
M10 (rigid joints)	45 / 33.2
M10 (contactless joints between surfaces)	20 / 14.7
M12 (bearings and plastic spheres joints)	10 / 7.3
M12 (rigid joints)	77 / 57
M12 (plastic joints)	40 / 29.5
M14 (rigid joints)	125 / 92
M14 (contactless joints between surfaces)	60 / 44.2
M16 (rigid joints)	190 / 140
M16 (contactless joints between surfaces)	80 / 59

(*) Subject to change depending on the modules. The installer must ensure that there is no damage or deformation when and after applying the torque. The installer must also ensure the torqueing yields the correct installation on the module fame.

Explanatory notes:

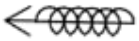
- Rigid joints: the connected pieces are in contact, or the separation between them is so small that after tightening to the correct torque they are totally in contact.
- Contactless joints: the connected pieces are not in contact after tightening to the correct torque. In this case, if they are tightened excessively, they could break or deform.

When completing the "Check List" and applying the tightening torque, record the ambient temperature..

- Tightening torque tolerances for rigid joints is ±10%
- Tightening torque tolerance for contactless joints is +0 / -10%

(*) TrinaTracker reserves the right to modify above indicated torque values. New values will be duly notified.

IMPORTANT SYMBOLS:

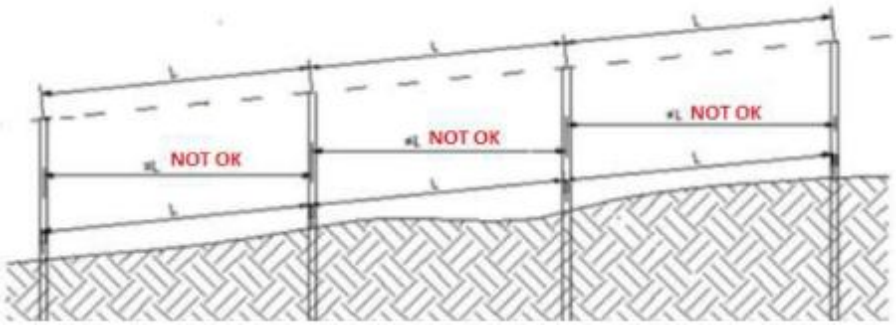
Symbol	Description
	Install hardware applying or without applying tightening torque.
	Move part in the direction of the arrow

3 TRACKER LAYOUT AND FOUNDATIONS

3.1. Tracker topographic layout

The position of the trackers, tracker boundaries and points where piles will be driven needs to be marked onsite according to the topographic layout positions.

In case of having certain slope on the terrain, marking must be done as shown in the image:



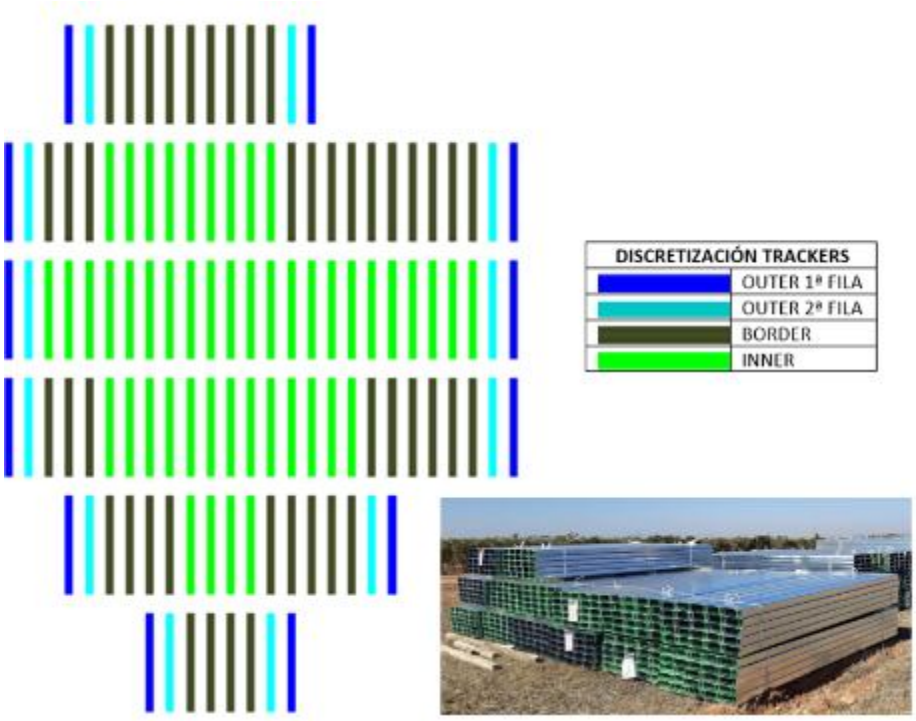
3.2. Piles identification and distribution

3.2.1. Identification

Refer to the site layout to identify tracker designations (outer 1st row, outer 2nd row, border row or inner row) locations.

Refer to the element ID drawing to identify staging areas for each pile type (standard and motor). The pile drawing shows the pile section, thickness and length.

(*) Each pile type is painted at the base with the color coding matching the foundations drawing.



3.2.2. Distribution

The piles will be distributed next to their designated tracker topographical marks (without touching the marks).

3.3. Tracker' foundation. Foundation design. Driving documents

[Foundation / POT Calculation Report]

[General and Elevation Drawings - GED]

[Element ID Drawings - EID]

[Pile Drawings – PD]

3.3.1. Tracker's foundation design

The position of the piles will depend on the type of foundation design:

1. Concrete foundations: embedded or screwed.
2. Micropiles dug in the ground: embedded or screwed.
3. Pile driving: direct driving or pre-drilling.

Refer to the above mentioned documents for the project specific foundation design.

3.3.2. Pile driving (with or without pre-drilling)

The plumbness of the pile installation is obtained by bumping the piles after they are driven. Ground characteristics (composition, homogeneity and hardness) play a fundamental role in the installation's final result.

VANGUARD tracker is equipped to absorb some imperfections (if they are within the below tolerances) and allows adjustment in North-South, East-West and height, to correctly adjust the final position of the tracker.

Tolerance type	Standard Post	Motor Post
North / South	± 5 cm / 1,9685 in. (β = ± 1°)	± 5 cm / 1,9685 in. (β = ± 1°)
East / West	± 1,5 cm / 0,591 in. (β = ± 0,4°)	± 1,5 cm / 0,591 in. (β = ± 0,4°)
Twisting	± 3°	± 0,5°
Height	± 20 mm / 0,788 in.	± 20 mm / 0,788 in.

(*)For reviewing on site, see appendix 02 (check list)

NOTE – – Pile driving recommendations and related procedures:

(*)(*) After tracker and pile stakeout and before the start of pile driving, check the alignment of the piles of each tracker (with a rope) and confirm the distances between piles concurs with the distances indicated at the [***General Drawing of plan and elevation – G]*** using a measuring tape.

(*)(*)(*) These adjustments are absolute tolerances, therefore, they cannot be accumulated between different posts on each tracker.

See below list of recommended tools:

1. Rope – to check the tracker East-West alignment.
2. Optical laser / Rope – to check the tracker height alignment.
3. Bubble level – to check the piles are vertically leveled.
4. Goniometer – for checking the twisting of the piles.

- **Use a protection shape or mold adaptable to the pile in the head of the anvil to avoid deformations on the head of the pile during the driving process.**

- **With the purpose of not damaging the piles during ramming process, it is recommended to use rubber protector or other equivalent material suitable for the described purpose, by adjusting to the machine metal guiding rod.**

- **In case of not reaching the minimum required embedment depth or pile reveal, the pile will be considered rejected. Trina Tracker must be informed and will validate the pile rejection following [Pull Out Test validation procedure].**

- **Pile driving accuracy and precision will impact the tracker's safe operation, durability, may cause damage to the tracker and personnel motor performance and may lead to excessive noise from the motor. The tracker is designed for specific embedment depths and reveal heights that must be followed. If it's noticed that the tracker is producing excessive noise, notify your Trina Tracker technical representative.**

- **For micro-grading and site civil works to meet the slopes refer to [Terrain Preparation Procedure].**

- **Trenches alongside the piles must be avoided as they cause pile' slippage. In case trenches are unavoidable, the following must be accomplished:**

  > Deep trenches ≥ 50 cm. / 20 in, dug in parallel (N-S) or perpendicular (E-W) to the longitudinal axis of the tracker **must be placed at a minimum distance of 1 m. / 40 in. from the pile's foot.**

  > Trenches dug for string wiring and/or for grounding of the installations, which end is near the piles, → **Must end at 50 cm. / 20 in. from the pile and approach to it with an inclination of 45º and a depth of 50 cm / 20 in.**

4 TRACKER MECHANICAL ASSEMBLY

[General floor and elevation drawing - GFED]

[Element ID drawing - EID]

[Exploded drawings – XP]

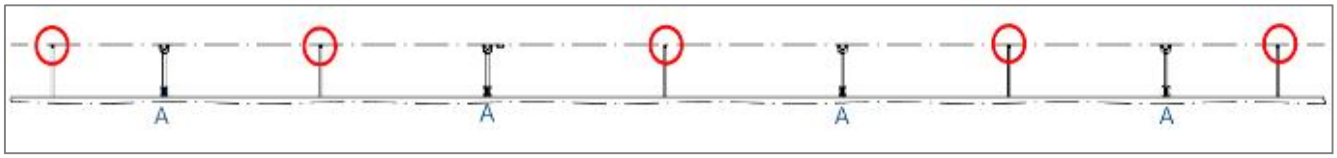
4.1. Pile - lower bearing support – actuator support system

4.1.1. Lower bearing supports assembly on piles

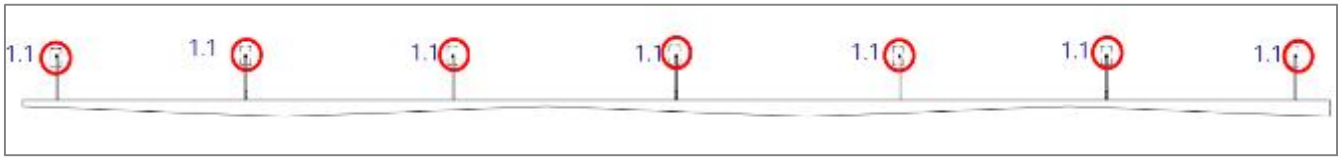
4.1.1.1. SIMPLE LOWER BEARING SUPPORT

Applies on:

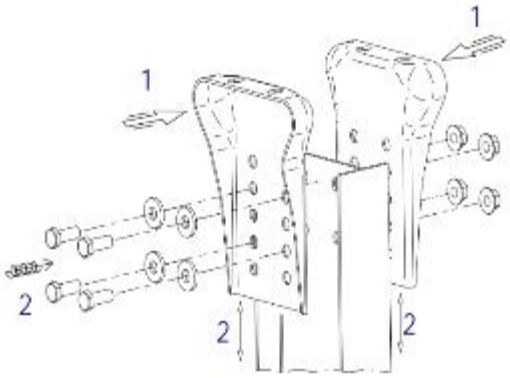
> **Outer 1st** trackers → Only to the **standard pile's** joints. In the motor pile joints, lower supports of double bearing will be used



> **Outer 2nd**, Border and Inner trackers → to all the joints of **standard and motor piles**

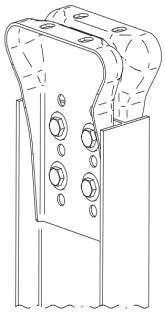


1



Install the 2 pieces that make the lower bearing support at both sides of each pile of the tracker. The height is adjusted by selecting the holes on the lower bearing support on the top of the pile

2

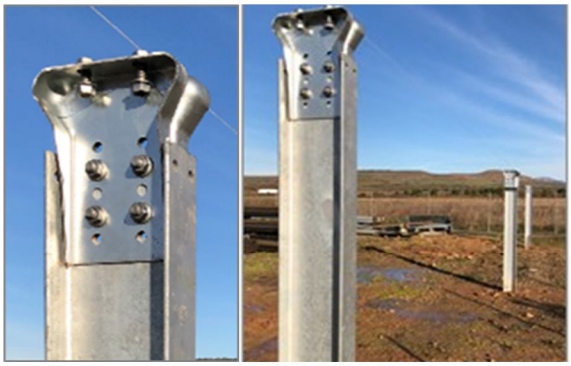


The lower bearing support is screwed to the pile, using the selected holes without applying the torque

3

To guarantee the correct height of each and every lower bearing supports that conforms with the tracker, a laser level or rope will be used.

After achieving the alignment, apply the tightening torque.



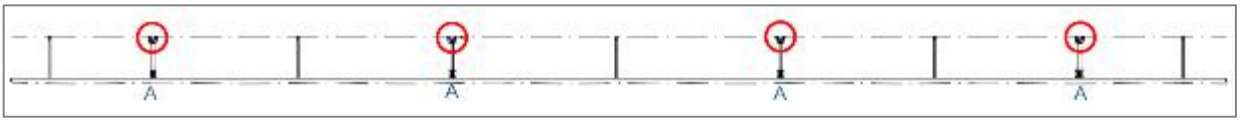
Assembled lower sopport view

Note: Install the hardware on alternating holes. I.e. leave an empty row of holes in between the installed bolts.

4.1.1.2. DOUBLE LOWER BEARING SUPPORT (1ST ROW OUTER) ON MOTOR PILE JOINTS

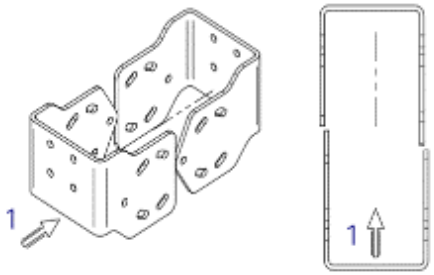
In case of:

> **Outer 1st** trackers→ Only to the **motor pile**'s joints.



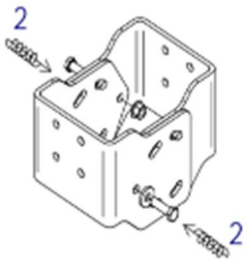
(*) Note: Pre-assemble the double lower bearing support on the ground. Steps 1-4.

1



Set both pieces of the motor pile bearing support.

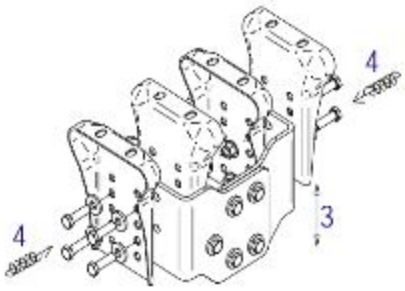
2



Both pieces are screwed without applying the tightening torque

3

4

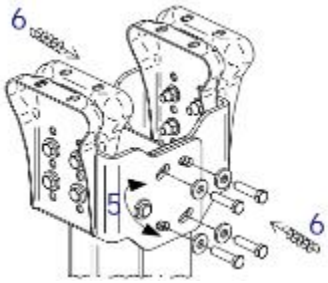


Adjust the height of the 4 pieces of lower bearing supports with the motor pile bearing support.

Install the hardware for the lower bearing supports and the motor pile bearing support without applying the tightening torque.

5

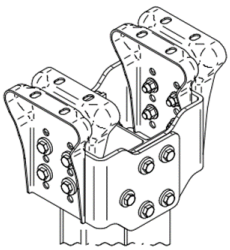
6



The slope of the lower bearing supports is adjusted with the grooves on the motor post bearing support.

Install the hardware for the motor pile bearing support without applying the tightening torque.

7

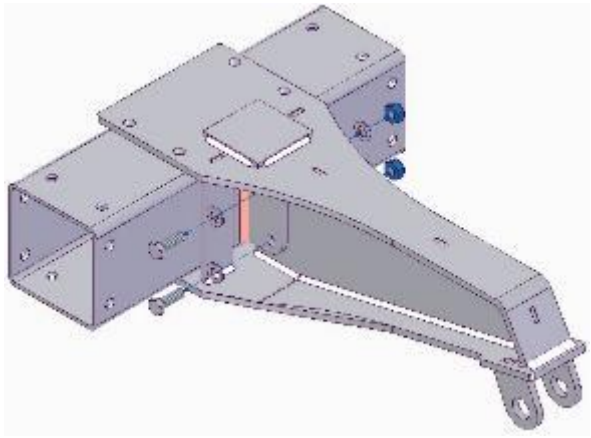


To guarantee the correct height alignment of each of the lower bearing supports that conforms with the tracker, a laser level or rope will be used.After completing the alignment, apply the tightening torque.

Note: Install the hardware on alternating holes. I.e. leave an empty row of holes in between the installed bolts.

4.1.2. Preassembly of the lever - *(Outer 1st Row, Outer 2nd Row, Border, Inner)*

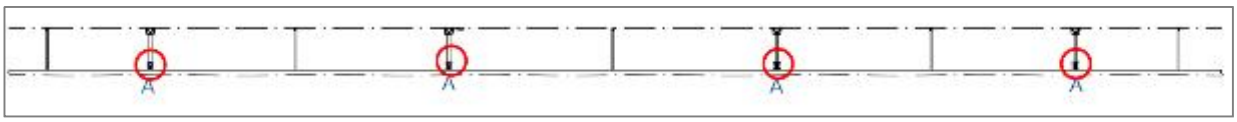
Insert the lever into the internal tube and attach the 2 Ø14 mm pass-through bolts to the side of the lever as shown in the following image.



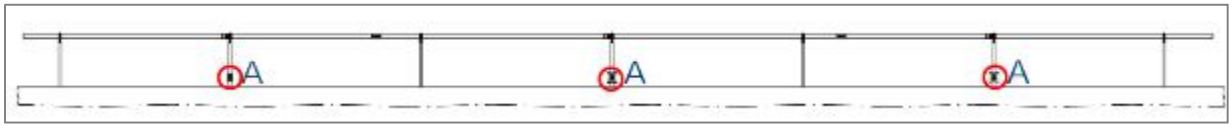
4.1.3. Actuator support assembly in motor piles - *(Outer 1st Row, Outer 2nd Row, Border, Inner)*

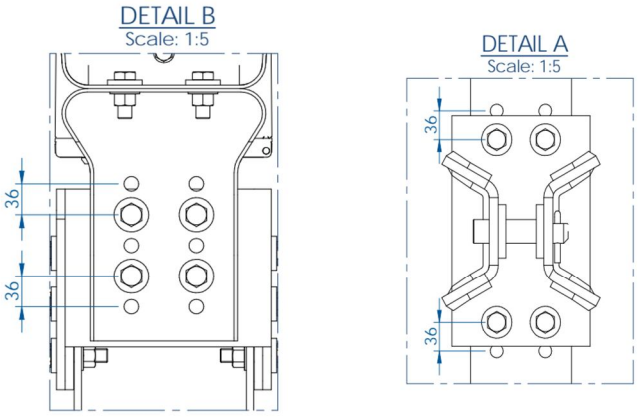
In case of:

On Outer 1st and Outer 2nd trackers → 4 actuator supports



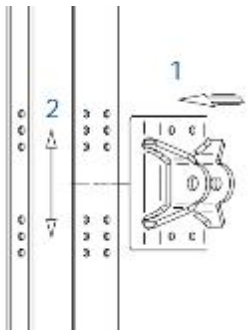
On Border and Inner trackers → 3 actuator supports





Height adjustment of the actuator support depends on the previous height adjustment of the lower bearing support.

1

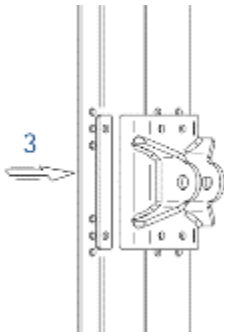


Place the actuator support over the motor pile

2

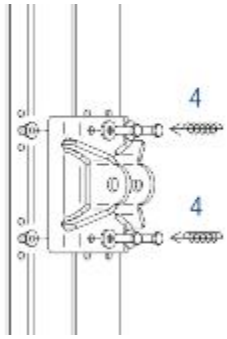
The height of the actuator support is adjusted based on the position of the lower bearing support holes

3



Add the rear reinforcement plates of the actuator support.

4



Insert the hardware needed for the actuator support, rear reinforcement plate and motor pile and then apply the tightening torque.

Assembled actuator support

4.2. Torque tube – Upper bearing support – Lever – Actuator System

NOTE – Initial concepts. Torque tube and catalogue configurations:

(*) The torque tube configurations are based on material composition and position of the elements to be pre-assembled on the torque tube and the position on the piles. They are project specific.

Template: Tracker Element – Tracker Element + Tracker Element – Pile type:

- > In **2nd Row Outer, Inner and Border** trackers – **1 tube configurations**:

  A. Motor Pile + Lever – Standard Pile – End of the tracker or Joining Clamp

  B. End of the tracker or Joining Clamp – Standard Pile – Motor Pile

  C. Motor Pile + Lever – Joining Clamp

  D. Joining Clamp – Motor Pile

(*) Orientation of the levers in 2nd Outer, Inner and Border will depend on N-S slope descending direction slope (always if slope is ≥4%):

- If the tracker slope descends Southbound: The lever will be installed oriented to the WEST
- If the tracker slope descends Northbound: The Lever will be installed oriented to the EAST

- > In **1st Row trackers – 2 tubes Configuration**:

  E. Joining Clamp or tracker end – Standard Pile – Motor Pile + Lever – Standard Pile – Tracker end or Joining Clamp.

F. Joining Clamp or tracker end – Standard Pile – Motor Pile + Lever – Tracker end or Joining Clamp

G. Joining Clamp or tracker end – Motor Pile + Lever – Standard Pile – Tracker end or Joining Clamp

H. Joining Clamp – Motor Pile – Joining Clamp

(*) The Lever orientation in 1st row Outer is shown in the ***[General floor and elevation drawing - GFED]*** and always follows the same orientation in ALL same type trackers.

(*) The possible configuration list depends on the type of tracker, the number of piles and on the relative position of posts and Joining Clamps.

- **Outer 1st and Outer 2nd** trackers (8 possible configurations)

  9 posts (4 Motor Posts and 5 Standard Posts) and 3 Torque Tube's Joining Clamps.

- **Border and Inner trackers** (4 possible configurations)

  7 posts (3 Motor Posts and 4 Standard Posts) and 2 Torque Tube's Joining Clamps.

(*) The **construction sequence** of the torque tube system will **depend on the design and engineering configuration for each of the trackers (Outer 1st, Outer 2nd and Inner**).

(*) The complete Configuration Catalogue can be seen in Appendix 01.

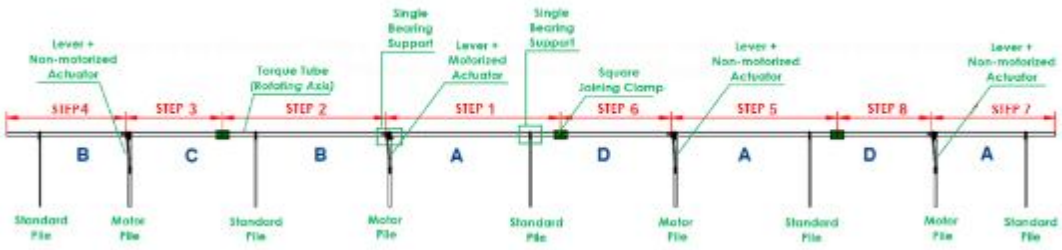
(*) On this assembly manual the construction sequence corresponding the following configurations that, due to design and engineering, came up as a result for this Project, although the rest of the configurations would be developed in a similar way.

If there is curvature on the torque tube (less than 0,25% of the length), install the torque tube with the convex side facing up so its own weight remedies the curvature.

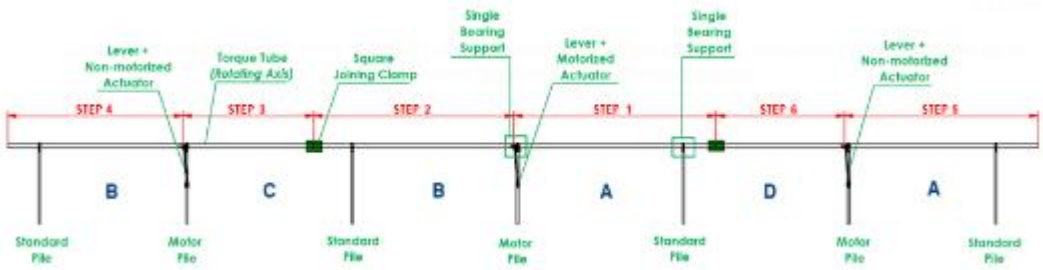
(*) Plastic caps assembly: the ends of the tubes on each row must be covered with a plastic cap.

(*) **End cups assembly:** The end of the tubes of each row must be covered with a plastic cup.

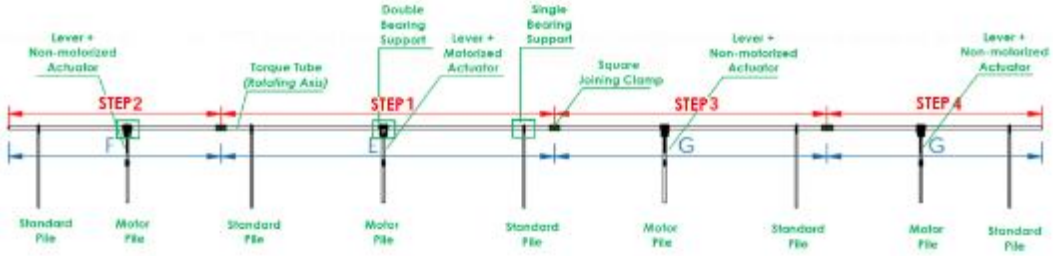
2nd row Outer configuration and assembly sequence



Inner and Border tracker configuration and assembly sequence



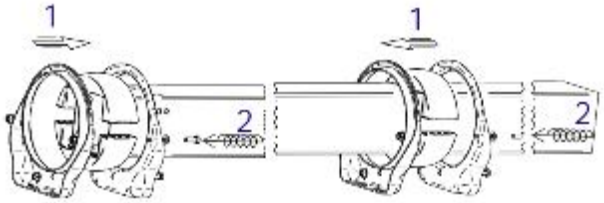
1st row Outer configuration and assembly sequence



4.2.1. Torque tube's "A Configuration" and placement over the lower bearing supports (2nd Outer, Border, Inner)

(*) Recommendation: Perform pre-assembly steps 1 – 7 at a 1.00 m - 1.20 m height to accommodate working position

1 **2**



Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence:

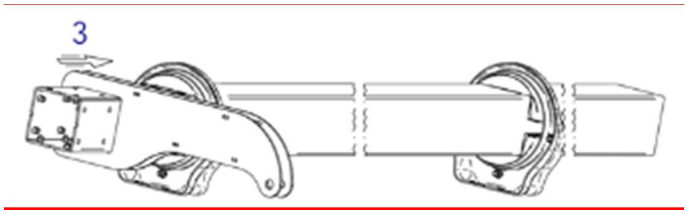
1 Slide the 1st piece of the upper bearing support through the torque tube end.

2 Fit the two plastic half-spheres on the torque tube.

3 Slide the 2nd piece of the upper bearing support.

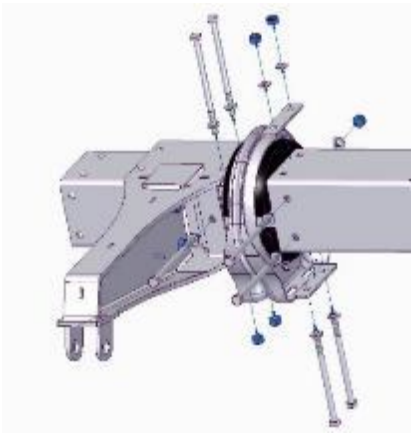
Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque

3



Slide the lever into the tube end and insert the 5 Ø14 pass-through bolts in order to attach the lever to the tubes and to the internal lever tube leaving all fixed.

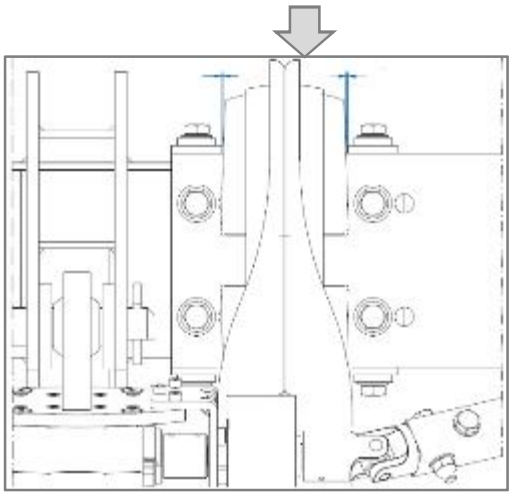
4 **5** **6**



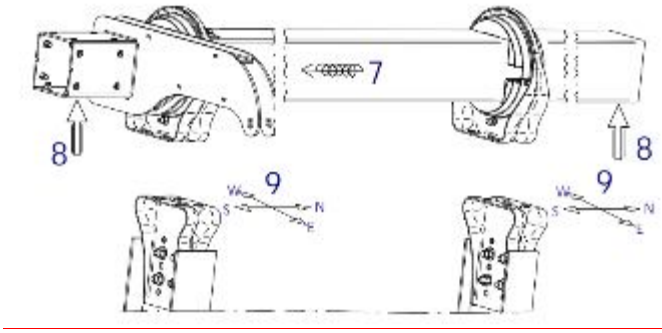
Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving both bearings between them and the lever

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

Apply the tightening torque to all the bolts. (side, top and bottom).

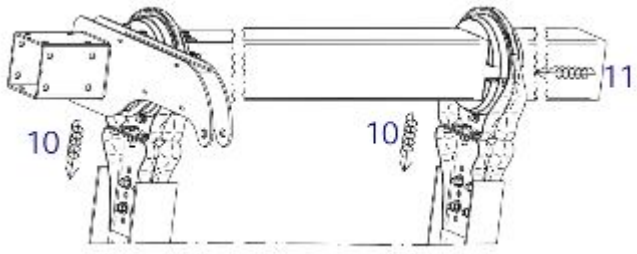


7 **8** **9**



Apply the tightening torque to the upper bearing support	This pre-assembly makes up the Tube's "A Configuration" (with lever + 2 upper bearing supports). Use a forklift to lift the pre-assembly to its final position on the lower bearing supports	Align the upper bearing supports with the lower bearing supports in N-S direction and E-W, absorbing the any foundation deviation.

10 **11**



Screw the upper bearing supports to the lower bearing supports and apply the tightening torque	Apply the tightening torque to the bearing support set of the standard and motor piles on the other side of the torque tube

Asembly proccess of Torque-Tube and placement over the lower bearing supports

4.2.2. Actuator assembly on the tube's "A Configuration"-(Outer 2nd, Border, Inner)

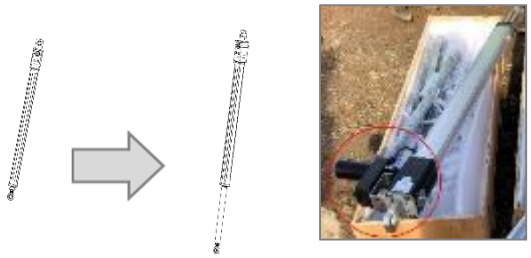
Motorized actuator assembly:

- Step 1 in Inner and Border trackers
- Step 1 in 2nd Outer trackers

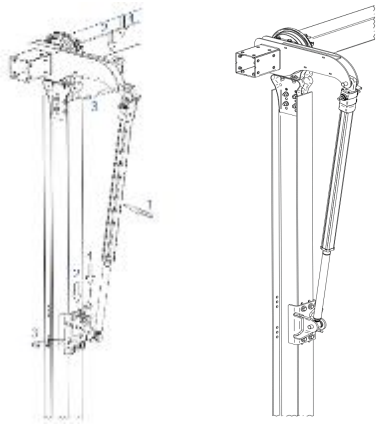
Trina Tracker will provide an auxiliary electric box with several connections to extend the actuator's stem.

DO NOT force the actuator to extend. For other methods of extending the actuator, consult with Trina Tracker's staff..

Extend the actuator stem up to a length of 2,030 mm / 80 in.



1 **2** **3** **4**



Insert the top end of the actuator into the lever first, and the bottom end to into the actuator support after..	**Insert 2 plastic bushings at the top end of the actuator between the lever and actuator. Insert 4 plastic bushings at the bottom end of the actuator between the actuator and the actuator support**	**While holding the actuator and the bushings in place, insert the two bolt pins through the holes in the lever (top) and in the actuator's support (bottom).**	**Insert the two cotter pins through the bolt pins at the top and bottom of the actuator and open them.**

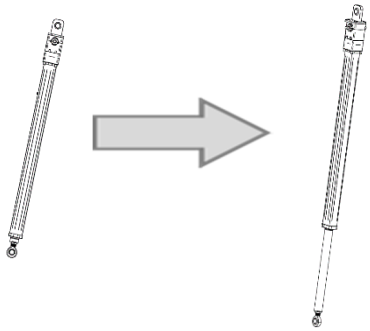
Non-motorized actuator assembly:

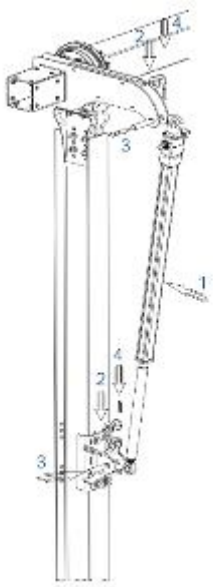
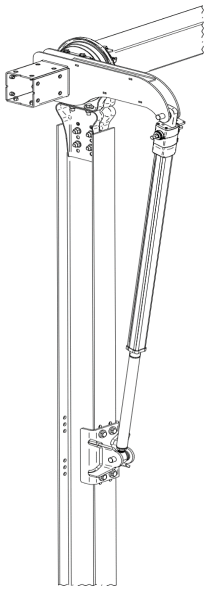
- Step 5 in Inner and Border trackers
- Steps 5 and 7 in 2nd row Outer trackers

Trina Tracker will provide an auxiliary electric box with several connections to extend of the actuator's stem.

DO NOT force the actuator to extend. For other methods of extending the actuator, consult with Trina Tracker's staff

Extend the actuator stem up to a length of 2,030 mm / 80 in

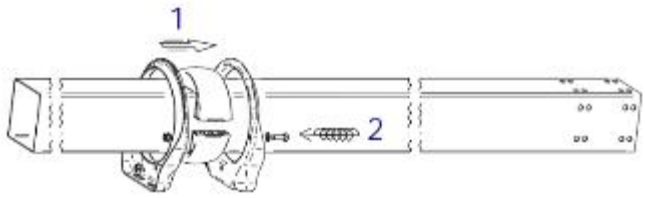


1	2	3	4
			
Insert the top end of the actuator into the lever first and the bottom end of the actuator into the actuator support after	**Insert 2 plastic bushings at the top end of the actuator between the lever and actuator. Insert 4 plastic bushings at the bottom end of the actuator between the actuator and the actuator support**	**While holding the actuator and the bushings in place, insert the two bolt pins through the holes in the lever (top) and in the actuator's support (bottom).**	**Insert the two cotter pins through the bolt pins at the top and bottom of the actuator and open them.**

4.2.3. Torque tube's "B Configuration" assembly and lower bearing support placement (Outer 2nd, Border, Inner

(*) Recommendation: Perform pre-assembly steps 1 – 7 at a 1.00 m -1.20 m height to accommodates working position

1



1. Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence:

1.1Slide the 1st piece of the upper bearing support through the torque tube end.

1.2 Fit the two plastic half-spheres on the torque tube.

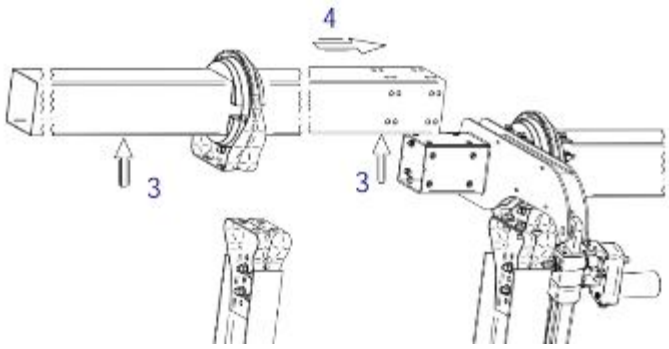
1.3 Slide the 2nd piece of the upper bearing support.)

2

Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque.

Adjust the position of the upper bearing support sets to align with the relative position of the pile and lower bearing support from the drawings (insert drawing sheet number). The exact location will be adjusted when installing the assembly on the piles. Ensure the upper bearing support set closest to the lever is located between the holes on the torque tube.

3



This pre-assembly makes the torque Tube's "B Configuration". With the upper bearing support and torque tube (without the joining clamp just yet). Use a forklift to raise this pre-assembly to its final position on the lower bearing support

4

Slide the torque tube into the lever.

And insert the lateral pass-through bolt to attach the lever to it.

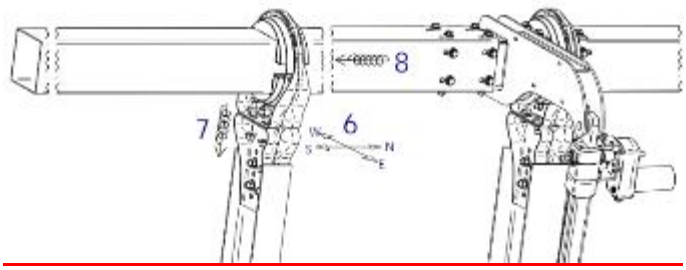
5 **6** **7**

Once the lever is inserted and fixed, place the breaking plates and the other M14 pass-through bolts as shown in the drawings, leaving the bearing between the breaking plate and the lever

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

Apply the tightening torque to all the bolts. (side, top and bottom).

8 **9** **10**



Adjust the Upper Bearing Support to the lower bearing support in N-S and E-W direction until they match and alignment is obtained.

Insert the hardware to install the upper bearing support on the lower bearing support and apply the tightening torque.

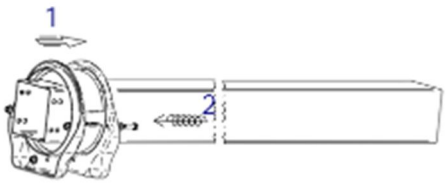
Apply the tightening torque to the upper bearing support

4.2.4. Torque tube's "C Configuration" and lower bearing support placement. (Outer 2nd, Border, Inner)

(*) Recommendation: Perform pre-assembly steps 1 – 7 at a 1.00 m -1.20 m height to accommodate working position.

1

2



. Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence:

1.1Slide the 1st piece of the upper bearing support through the torque tube end.

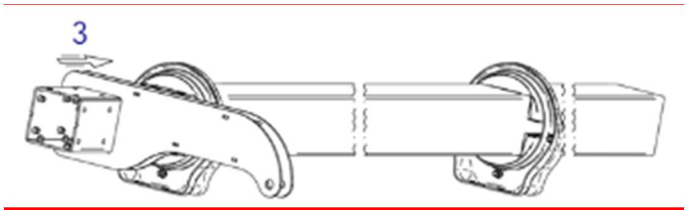
1.2 Fit the two plastic half-spheres on the torque tube.

1.3 Slide the 2nd piece of the upper bearing support.

Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque.

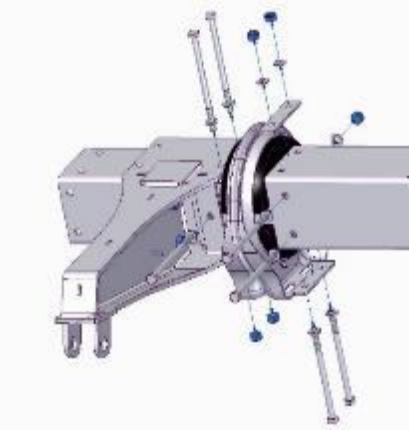
Adjust the position of the upper bearing support sets to align with the relative position of the pile and lower bearing support from the drawings (insert drawing sheet number). The exact location will be adjusted when installing the assembly on the piles. Ensure the upper bearing support set closest to the lever is located between the holes on the torque tube.

3



Slide the lever into the tube end and insert the 5 Ø14 mm pass-through bolts in order to attach the lever to the tubes and to the internal lever tube leaving all fixed.

4 **5** **6**

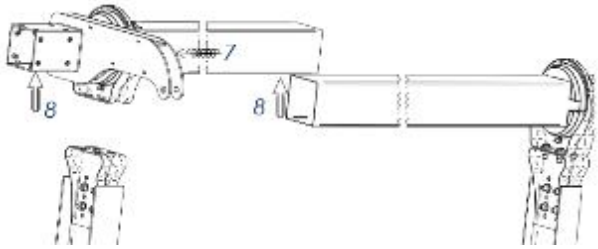


Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving the bearing between the breaking plate and the lever

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

Apply the tightening torque to all the bolts. (side, top and bottom).

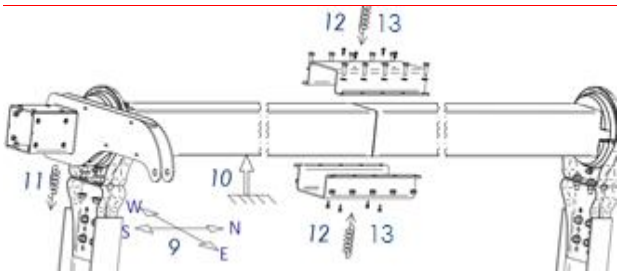
7 **8**



Apply the tightening torque to the upper bearing support.

This pre-assembly makes up the Tube's "C Configuration" (with lever + 2 upper bearing supports) Use a forklift to lift the pre-assembly to its final position on the lower bearing supports .

9 **10** **11**

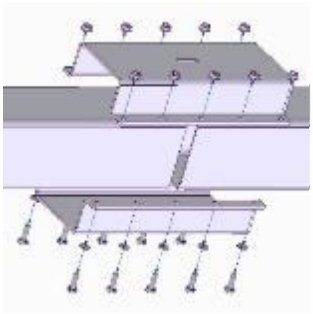


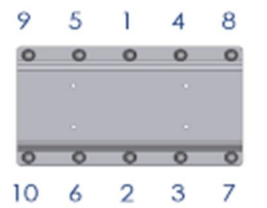
Align the upper bearing supports with the lower bearing supports in N-S direction and E-W, absorbing any foundation deviation

The set stays raised (with a forklift) while the last 2 steps are performed

Screw the upper bearing supports to the lower bearing supports and apply the tightening torque.

12 **13**

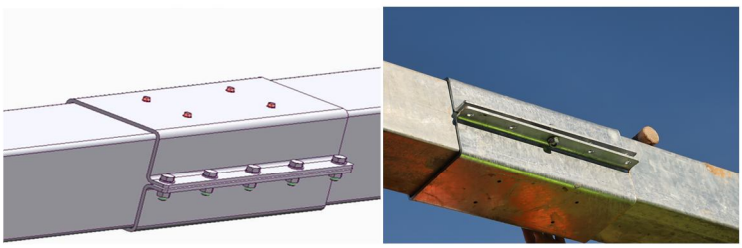




Place the two pieces of joining clamps (upper and lower) wrapping both sections of the torque tube. Install the hardware and apply the tightening torque following the sequence on the right.

Check that the tubes stay at a minimum distance of 5 mm inside the joining clamps.

Both tubes must be seen through the joining clamp's window.



Assembled joining clamps

4.2.5. Tube's "C Configuration" actuator assembly (Outer 2nd, Border, Inner)

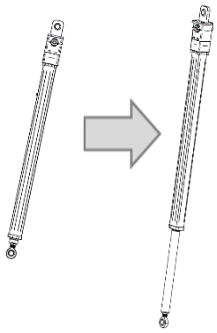
Non-motorized actuator assembly:

- Step 3 in Inner and Border trackers
- Step 3 in 2nd row Outer tracker

Trina Tracker will provide an auxiliary electric box with several connections to extend the actuator's stem.

DO NOT force the actuator to extend. For other methods of extending the actuator, consult with Trina Tracker's staff

Extend the actuator stem up to a to a length of 2,030 mm / 80 in



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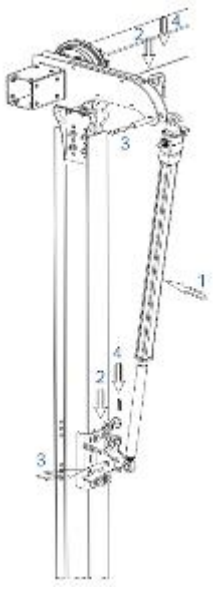
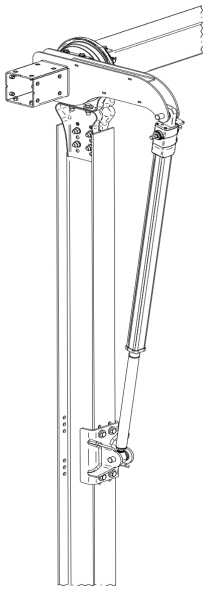
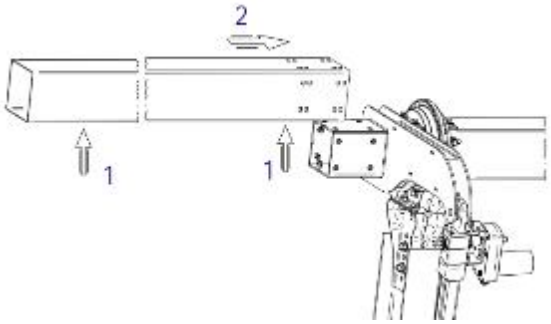
			
Insert the top end of the actuator into the lever and then the bottom end to into the actuator support	Insert 2 plastic bushings at the top end of the actuator between the lever and actuator. Insert 4 plastic bushings at the bottom end of the actuator between the actuator and the actuator support.	While holding the actuator and the bushings in place, insert the two bolt pins through the holes in the lever (top) and in the actuator's support (bottom)	Insert the two cotter pins through the bolt pins at the top and bottom of the actuator and open them..

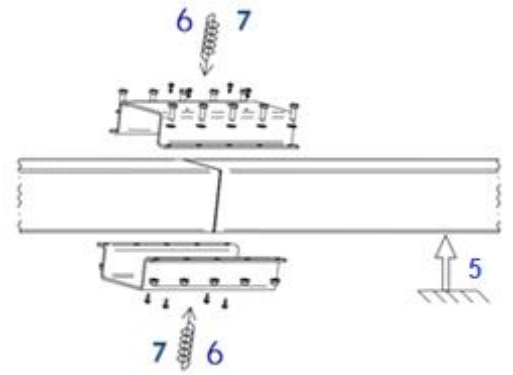
4.2.6. Torque tube's "D Configuration" assembly and lower bearing support placement. (Outer 2nd, Border, Inner)



1	2	3	4
Use a forklift to lift the torque tube section	Move the torque tube towards the end of the Lever	The tube is kept elevated (with lifting tools) while the Tube-Lever connection is being made.	Insert the lateral pass-through bolt (the one parallel to the torque tube) to attach the lever to it.

5	6	7
Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving the bearing between the breaking plate and the lever	(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.	Apply the tightening torque to all the bolts. (side, top and bottom).

8 **9**

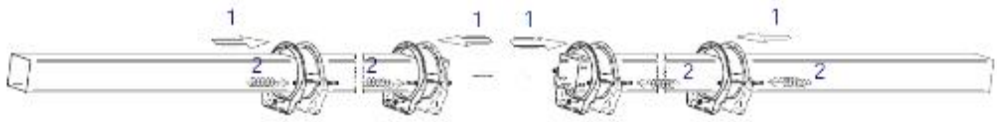


Keep the torque tube elevated	**Place both (top and bottom) pieces of the joining clamp wrapping around the torque tube sections. Install the hardware based on the below sequence and apply the tightening torque.**	

4.2.7. vii. Torque tube's "E Configuration" assembly and lower bearing support placement - Outer 1st Row

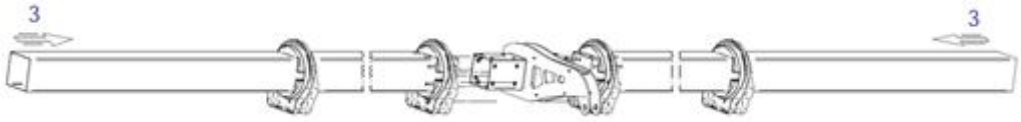
(*) Recommendation: Perform pre-assembly steps 1 – 6 at a 1.00 m -1.20 m height to accommodate working position.

1 **2**

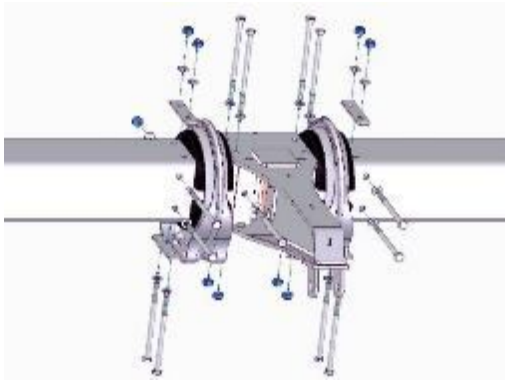


Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence (total 4 sets of supports) **1.1 Slide the 1st piece of the upper bearing support through the torque tube end.** **1.2 Fit the two plastic half-spheres on the torque tube.** **1.3 Slide the 2nd piece of the upper bearing support.**	**Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque.**

3



Place the lever between the two torques tube ends and slide the two torque tubes into the lever.



4

Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving the bearings between them and the lever

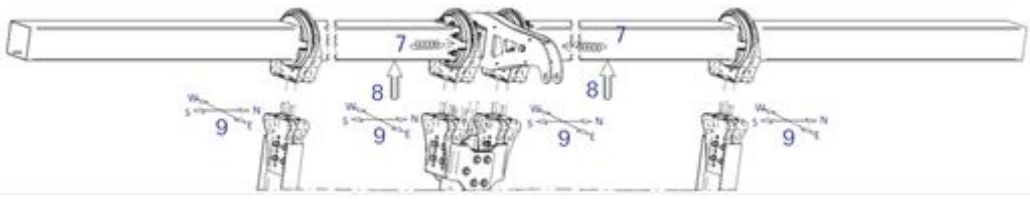
5

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

6

Apply the tightening torque to all the bolts. (side, top and bottom).

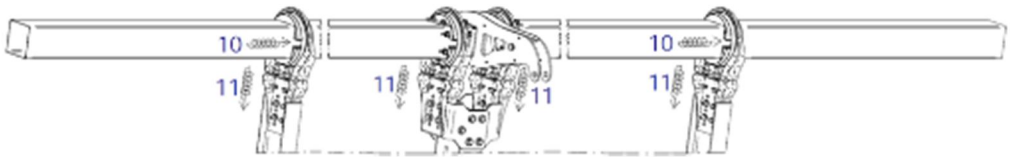
7 **8** **9**



Apply the tightening torque to the two upper bearing sets of the motor pile on either side of the lever.

Use a forklift to lift the torque tube (2 units) + lever (1 unit) + upper bearing supports sets (4 units) from its pre-assembly position to the final position above the lower bearing supports.

Align the upper bearing supports with the lower bearing supports in N-S direction and E-W direction.

10	11
	
Apply the tightening torque to the upper bearing set of the standard piles.	**Install the hardware for attaching the upper bearing support to the lower bearing supports and apply the tightening torque.**

4.2.8. viii. Torque tube's "E Configuration" actuator assembly (Outer 1st Row)

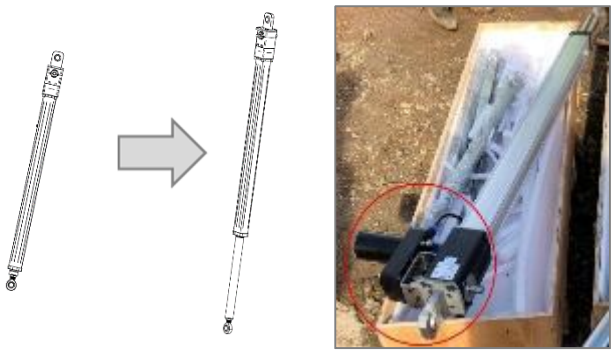
Motorized actuator assembly:

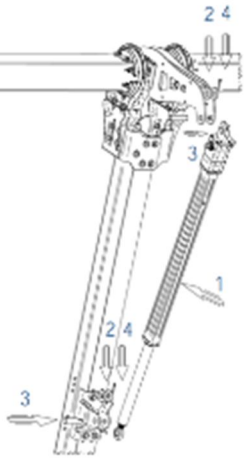
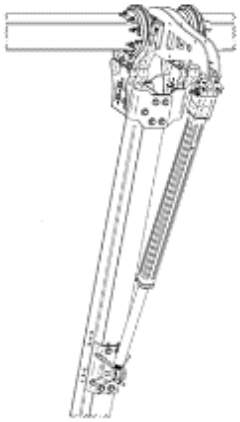
- Step 1 in 1st row Outer trackers

Trina Tracker will provide an auxiliary electric box with several connections to extend of the actuator's stem.

DO NOT force the actuator to extend. For other methods of extending the actuator, consult with Trina Tracker's staff.

Actuator's stem is extended up to a length of 2,030 mm / 80 in



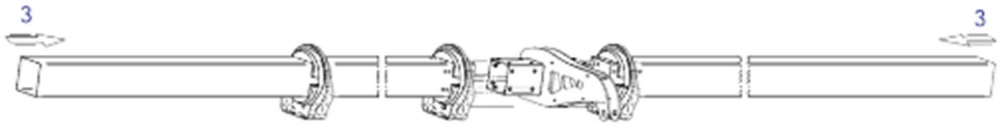
1	2	3	4
			
Insert the top end of the actuator into the lever first and the bottom end to into the actuator support after.	Insert 2 plastic bushings at the top end of the actuator between the lever and actuator. Insert 4 plastic bushings at the bottom end of the actuator between the actuator and the actuator support.	While holding the actuator and the bushings in place, insert the two bolt pins through the holes in the lever (top) and in the actuator's support (bottom).	Insert the two cotter pins through the bolt pins at the top and bottom of the actuator and open them.

4.2.9. Torque tube's "F Configuration" assembly and placement over lower bearing supports (Outer 1st Row)

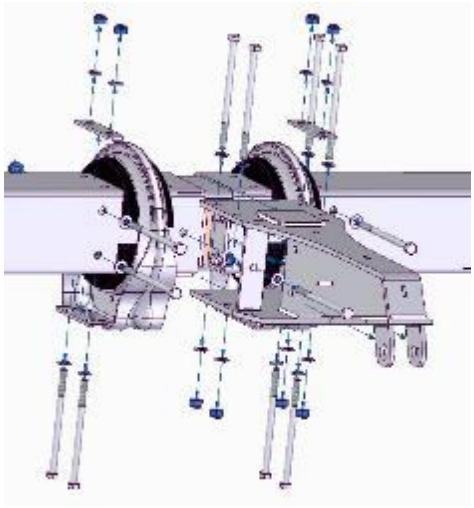
(*) Recommendation: Perform pre-assembly steps 1 –67 at a 1.00 m -1.20 m height to accommodates working position.

1	2
	
Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence (total 3 support sets): 1.1 Slide the 1st piece of the upper bearing support through the torque tube end. 1.2 Fit the two plastic half-spheres on the torque tube. 1.3 Slide the 2nd piece of the upper bearing support.	Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque.

3



Place the lever between the two torque tube ends and slide the two torque tubes into the lever.



4

Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving the bearings between them and the lever

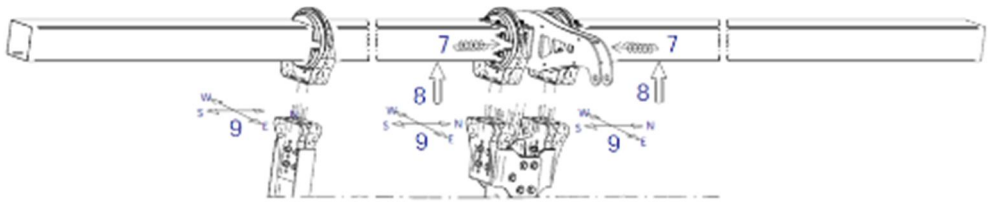
5

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

6

Apply the tightening torque to all the bolts. (side, top and bottom).

7 **8** **9**

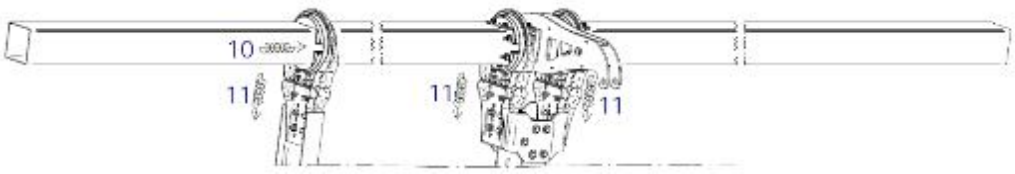


Apply the tightening torque to the two upper bearing sets of the motor pile on either side of the lever

Use a forklift to lift the torque tube (2 units) + lever (1 unit) + upper bearing supports sets (3 units) from its pre-assembly position to the final position above the lower bearing supports.

Align the upper bearing supports with the lower bearing supports in N-S direction and E-W direction

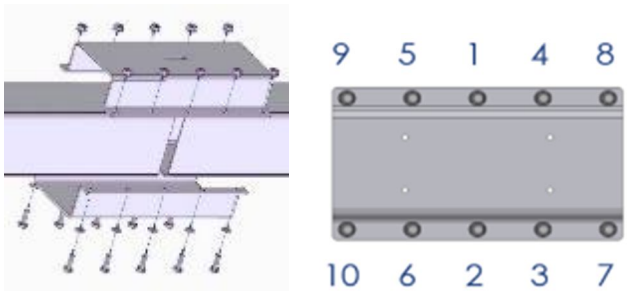
10



Apply the tightening torque to the upper bearing set of the standard piles

11

Install the hardware for attaching the upper bearing support to the lower bearing supports and apply the tightening torque.



12

Place both (top and bottom) pieces of the joining clamp wrapping around the torque tube sections. Install the hardware based on the below sequence and apply the tightening torque.

Check that the tubes stay at a minimum distance of 5 mm inside the joining clamps.

Both tubes must be seen through the joining clamp's window.

4.2.10. Torque tube's "F Configuration" actuator assembly (Outer 1st row)

Non-Motorized Actuator Assembly:

- Step 2 in 1st row Outer

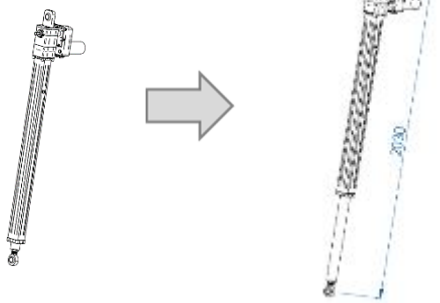
(*) Note: Stem extension systems in Non-motorized Actuators

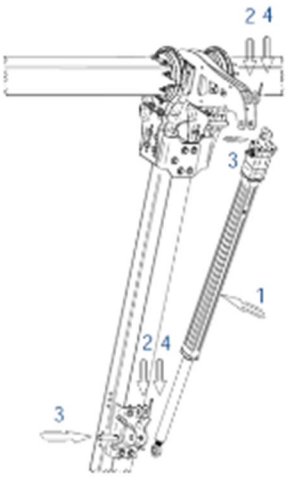
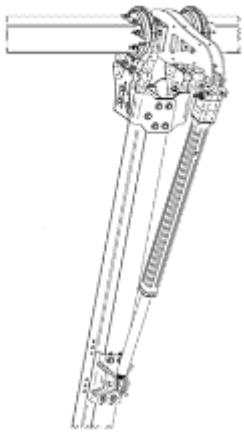
Non-Motorized Actuators assembly sequence Will be described, in tubes "E Configuration".

Trina Tracker will provide an auxiliary electric box with several connections to extend of the actuator's stem.

DO NOT force the actuator to extend. For other methods of extending the actuator, consult with Trina Tracker's staff.

Actuator's stem is extended up to a length of 2,030mm / 80 in

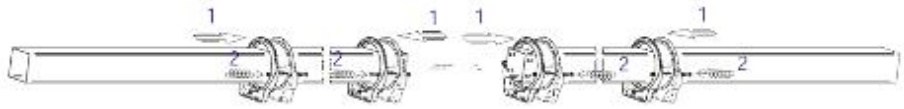


1	2	3	4
			
Insert the top end of the actuator into the lever first and the bottom end to into the actuator support after.	**Insert 2 plastic bushings at the top end of the actuator between the lever and actuator. Insert 4 plastic bushings at the bottom end of the actuator between the actuator and the actuator support.**	**While holding the actuator and the bushings in place, insert the two bolt pins through the holes in the lever (top) and in the actuator's support (bottom).**	**Insert the two cotter pins through the bolt pins at the top and bottom of the actuator and open them**

4.2.11. Torque tube's "G Configuration" and placement over lower bearing supports (Outer 1st row)

(*) Recommendation: Perform pre-assembly steps 1 –67 at a 1.00 m -1.20 m height to accommodates working position

1



Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence (total 3 support sets):

1.1 Slide the 1st piece of the upper bearing support through the torque tube end.

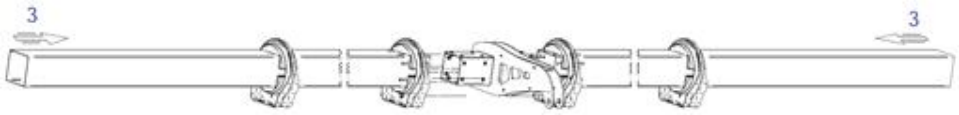
1.2 Fit the two plastic half-spheres on the torque tube.

1.3 Slide the 2nd piece of the upper bearing support.

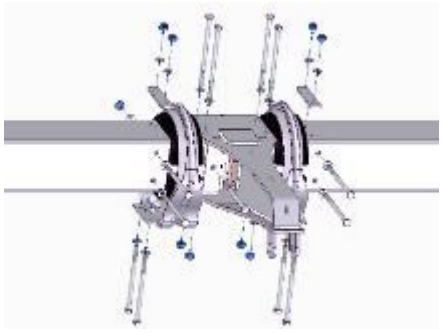
2

Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque.

3



Place the lever between the two torque tube ends and slide the two torque tubes onto the lever.



4

Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving the bearings between them and the lever

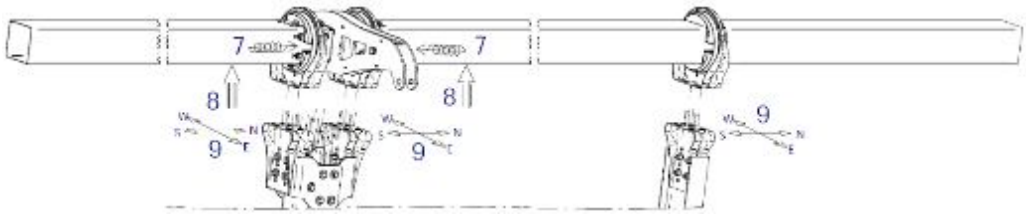
5

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

6

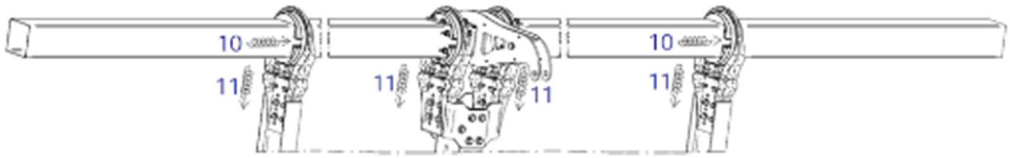
Apply the tightening torque to all the bolts. (side, top and bottom).

7 **8** **9**



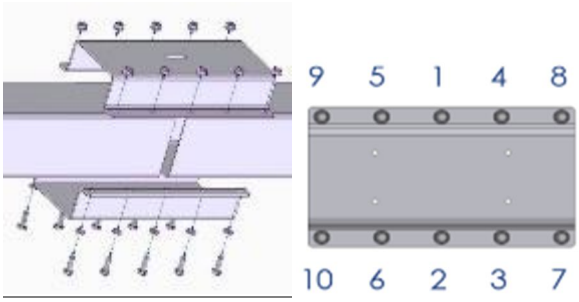
Apply the tightening torque to the two upper bearing sets of the motor pile on either side of the lever	Use a forklift to lift the torque tube (2 units) + lever (1 unit) + upper bearing supports sets (3 units) from its pre-assembly position to the final position above the lower bearing supports.	Align the upper bearing supports with the lower bearing supports in N-S direction and E-W direction

10 **11**



Apply the tightening torque to the upper bearing set of the standard piles.	Install the hardware for attaching the upper bearing support to the lower bearing supports and apply the tightening torque.

12



Place both (top and bottom) pieces of the joining clamp wrapping around the torque tube sections. Install the hardware based on the below sequence and apply the tightening torque	Check that the tubes stay at a minimum distance of 5 mm inside the joining clamps. Both tubes must be seen through the joining clamp's window.

4.2.12. xii. Torque tube's "G Configuration" actuator assembly (1st row Outer)

Non-Motorized actuator assembly

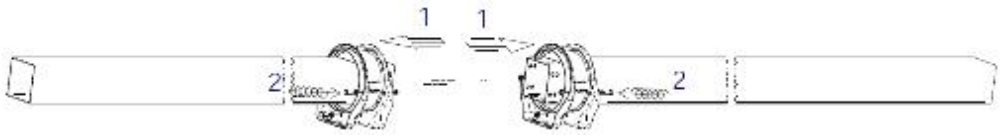
- Step 3 and 4 in 1st Row Outer Tracker

(*) Follow the same installation steps as torque tube's "F Configuration", part (x)

4.2.13. xiii. Torque Tube's "H Configuration" and placement over the Lower Bearing Supports (1st row Outer)

(*) (Recommendation: Perform pre-assembly steps 1 – 6 at a 1.00 m -1.20 m height to accommodate working position The Upper Bearing Support is introduced through the tube ends according to the following sequence:

1



Slide the two upper bearing supports and plastic bearings through the tube ends according to the following sequence (total 2 sets of supports):

1.1 Slide the 1st piece of the upper bearing support through the torque tube end.

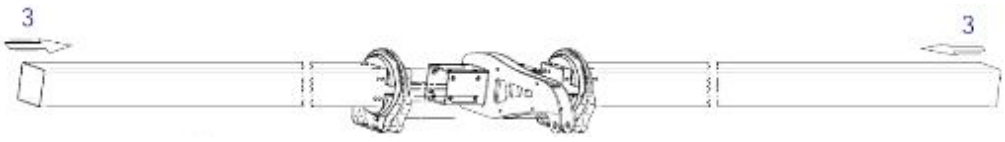
1.2 Fit the two plastic half-spheres on the torque tube.

….1.3 Slide the 2nd piece of the upper bearing support.

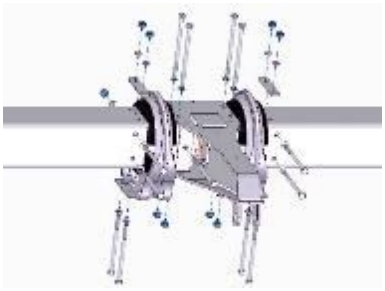
2

Bring the two pieces of the upper bearing support close together, enclosing the plastic bearings. Install the hardware without applying the tightening torque.

3



Place the lever between the two torque tube ends and slide the two torque tubes onto the lever.



4

Once the lever is inserted and fixed, place the breaking plates and the other Ø14 mm pass-through bolts as shown in the drawings, leaving the bearing between them and the lever

(*) The upper bearing support must be placed at a minimum distance of 2 mm between brakes and lever.

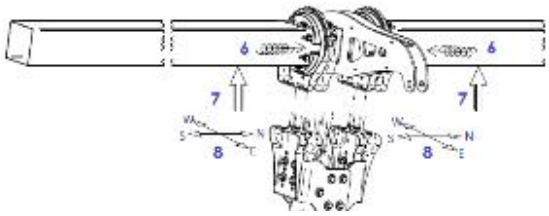
5

Apply the tightening torque to all the bolts. (side, top and bottom).

6

Apply the tightening torque to the two upper bearing sets of the motor pile on either side of the lever.

7

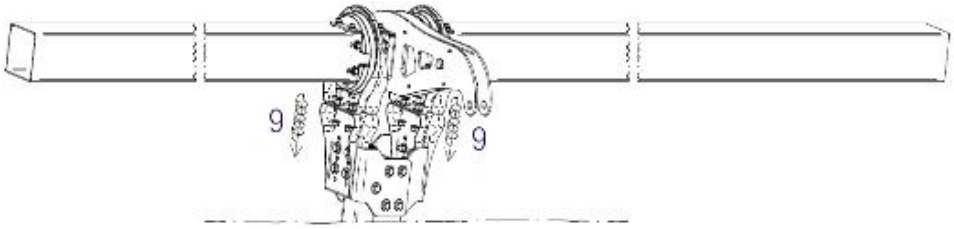


Use a forklift to lift the torque tube (2 units) + lever (1 unit) + upper bearing supports sets (2 units) from its pre-assembly position to the final position above the lower bearing supports.

8

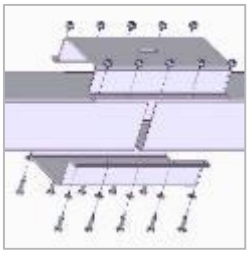
Align the upper bearing supports with the lower bearing supports in N-S direction and E-W direction.

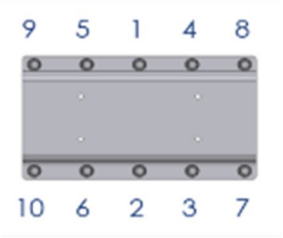
9



Install the hardware for attaching the upper bearing support to the lower bearing supports and apply the tightening torque.

10





Place both (top and bottom) pieces of the joining clamp wrapping around the torque tube sections. Install the hardware based on the below sequence and apply the tightening torque.

Check that the tubes stay at a minimum distance of 5 mm inside the joining clamps.

Both tubes must be seen through the joining clamp's window.

4.2.14. Torque Tube's "H Configuration" Actuator Assembly (1st row Outer).

Non-motorized actuator assembly

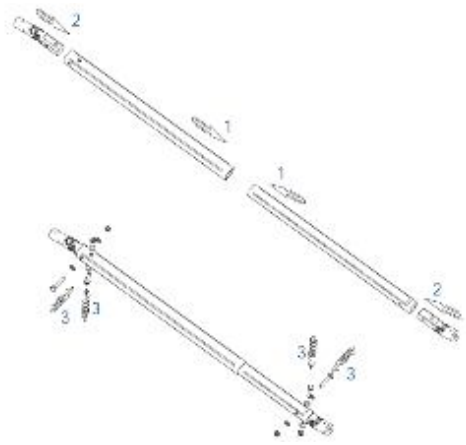
(*) Follow the same installation steps as torque tube's "F Configuration", part (x)

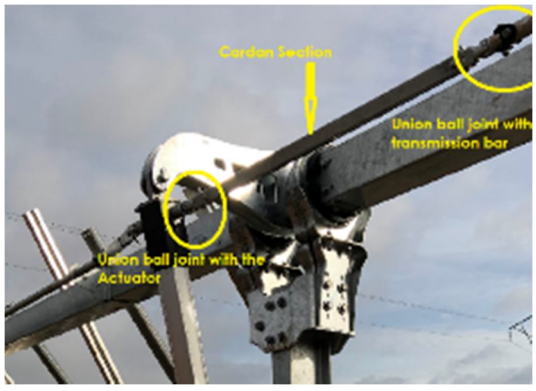
4.3. Cardan – transmission bar system assembly

4.3.1. Cardan's preassembly

(*) Cardan – are defined as the diagonal bars to the tracker's rotating axis.

1 **2** **3**



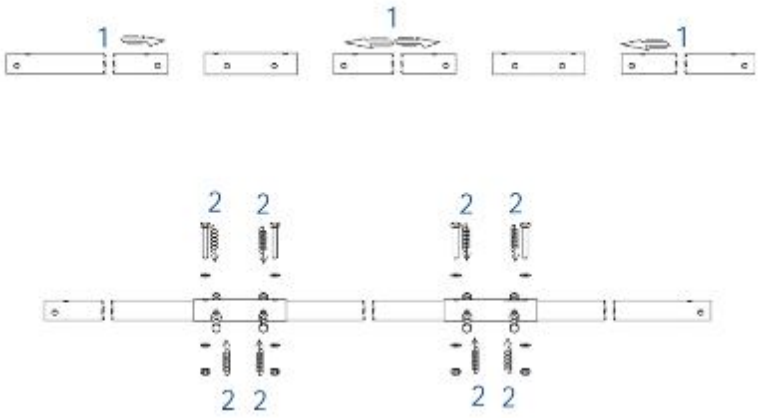


Insert the 2 cardan bars into each other. One will overlap the other	**Insert the union joints with the actuator and the transmission bar at the ends of the cardan**	**Install the ball joints using the hardware and apply the torque tightening**

4.3.2. Pre-assembly of the transmission bars

(*) Transmission Bar – the bars parallel to the axis of rotation of the tracker

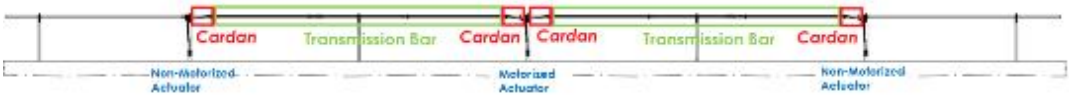
1 **2**



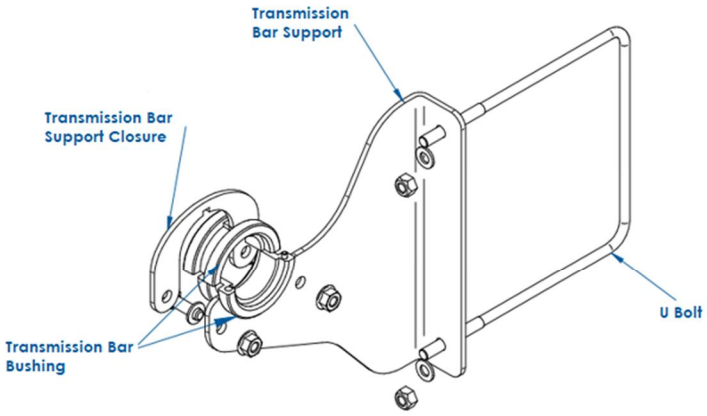
Transmission bars are connected (long sections) to each other by the center joints	**Install the hardware to connect the joints and apply the torque tightening.**

4.3.3. Assembly of transmission system

General scheme of the transmission system in the tracker (Inner / Border)

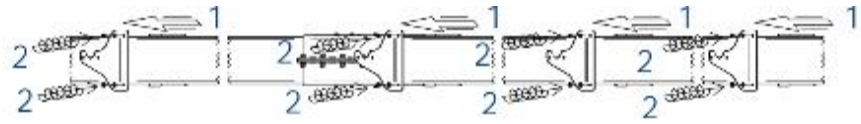


Transmission bars mounting set



Recommendation: pre-assemble the transmission bars mounting sets on the ground

1

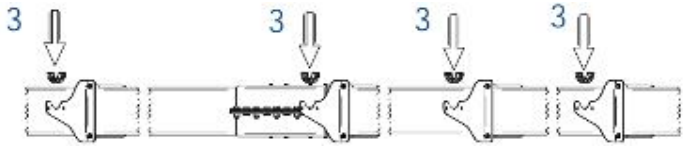


Insert the U-bolt into the Torque tube

2

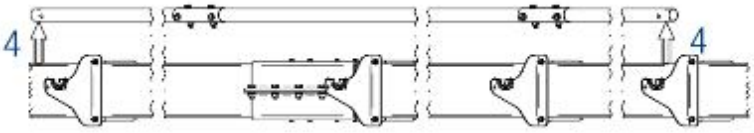
. Install the transmission bar support to the U-bolt and apply the tightening torque.

3



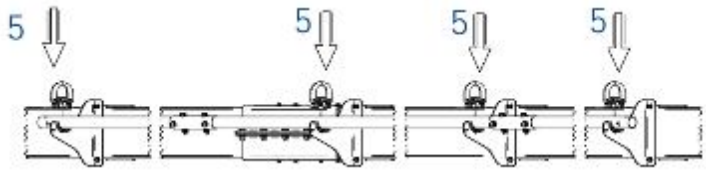
Place the transmission bar's lower bushings (lower piece) over the transmission bar support

4



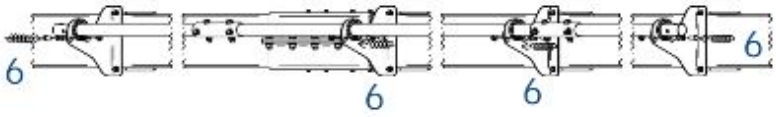
Pre-assembled transmission bar set (as per part 4.3.2) is lifted on the transmission bar supports.

5



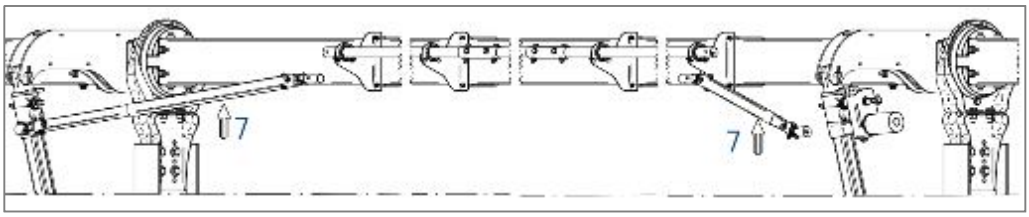
Place transmission bar upper bushing and support closure on top of transmission bar supports.

6



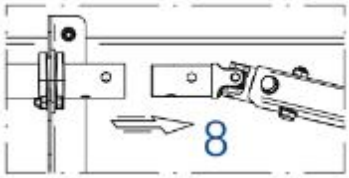
Install the hardware for the transmission bar support locks and apply torque tightening

7



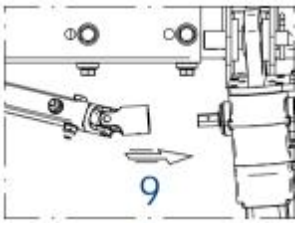
Lift the pre-assembled cardans to the transmission bars.

8



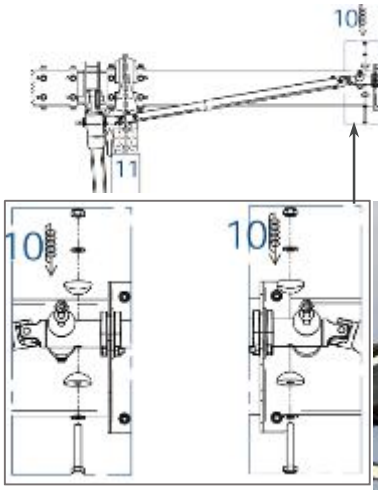
The upper end of the cardan is inserted at the end of the transmission bar.

9



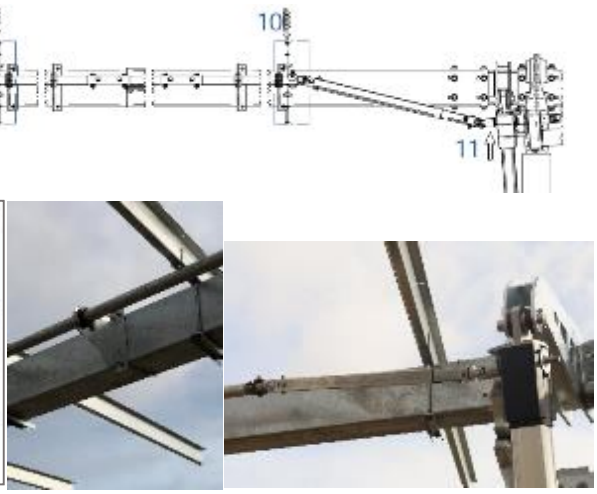
The lower end of the cardan is inserted on the hexagonal pin protruding from the actuator. Adjust the length as necessary for the cardan.

10



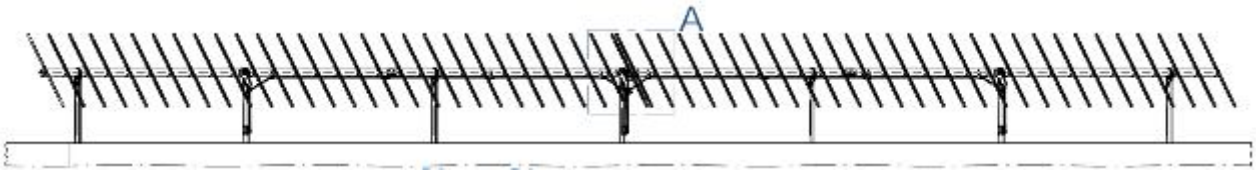
Install the hardware for the cardan and the transmission bar and apply torque tightening.

11

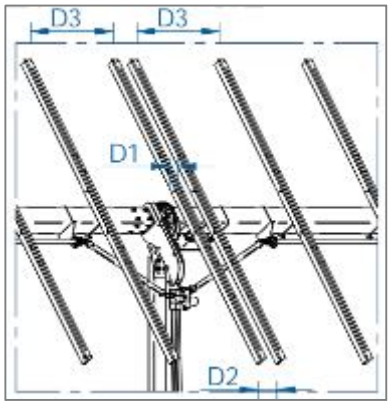


Insert the cotter pin inserted through the cardan and the top part of the actuator and open the cotter pin

4.4. Purlin assembly



(*) Recommendation: It is recommended to manufacture templates with the geometry of the module (only frame and holes of the purlin) → dummy module frames and holes.



1. Starting with the first purlin of the self-powered module. It Place it at the distance (D1) from the bearing, indicated on ***[General floor and elevation drawing – GFED - Detail B].*** Place the 2nd purlin of the self-powered module at a distance of (D2) from the

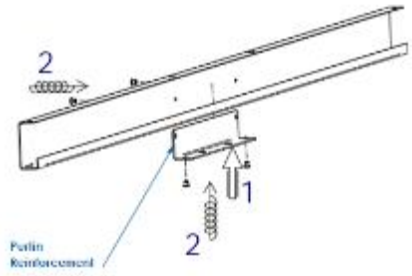
2. Place the 2nd purlin of the self-powered module at a distance of (D2) from the first purlin of the self-powered module, indicated on ***[General floor and elevation drawing – GFED - Detail B]***.

3. The assembly of the purlins continues on either side of the tracker towards the ends, taking as reference the 2 purlins of the Self-Powered module already installed. The following purlins will be placed at a distance (D3) from the outer edge, indicated in ***[General floor and elevation drawing – GFED - Detail B].***

Note: In the case of a string or hard wired system, the assembly of the purlins will use the actuator post with the motor as reference and the distances specified in the drawings.

4.4.1. "C type" end purlins assembly

1



Insert the purlin reinforcement under "C type" purlin.

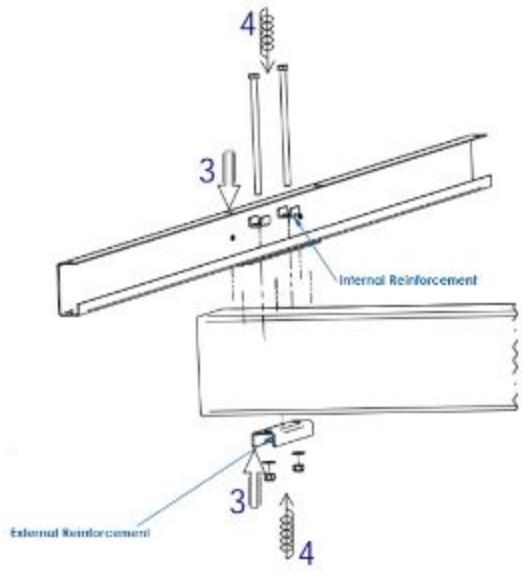
(*) Check that the holes in the purlin and in the purlin reinforcement align.

2

The set of purlin reinforcement – install the 4 rivets "C type" purlin

(*) Note: In some projects the purlin reinforcement – purlin set may come pre-assembled from the factory

3



Place the "C type" purlin on the tube in the location specified in the drawings (reference drawing sheet number).

4

Install the "C type" purlin to the tube with 2 through bolts as shown in the diagram

It's recommended to pre-assemble the purlin mounting sets on the ground..

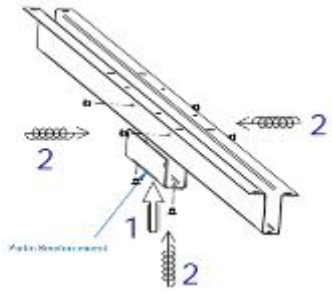
4.4.2. Ω type' End Purlins Assembly

1

Install the purlin reinforcement under the 'Ω type' purlin.

(*) Check that the holes in the purlin and in the purlin reinforcement align

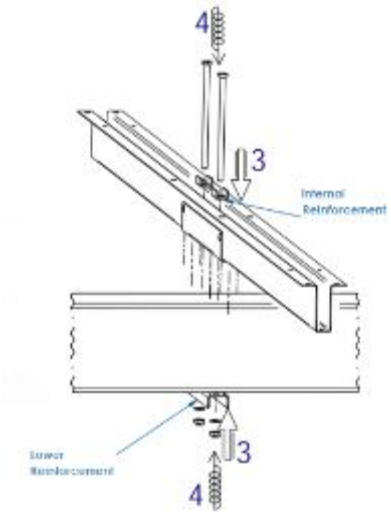
2



the "Ω type" purlin reinforcement – install the 6 rivets.

(*) Note: In some projects the purlin reinforcement – purlin set may come pre-assembled from the factory

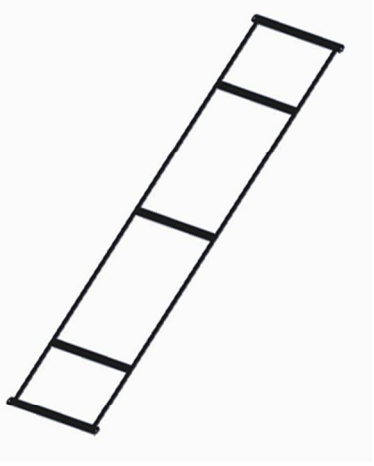
3



Place the "Ω type" purlin on the torque tube.

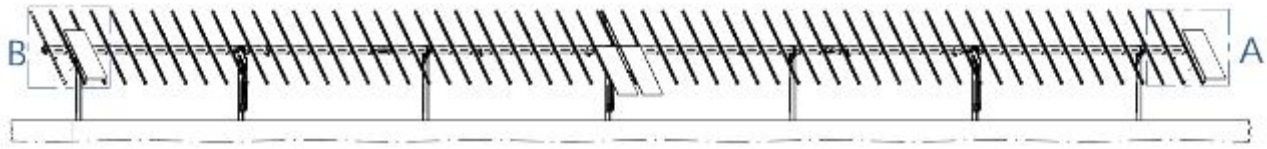
4

Install "Ω type" purlin to the torque tube with 2 through bolts as shown.

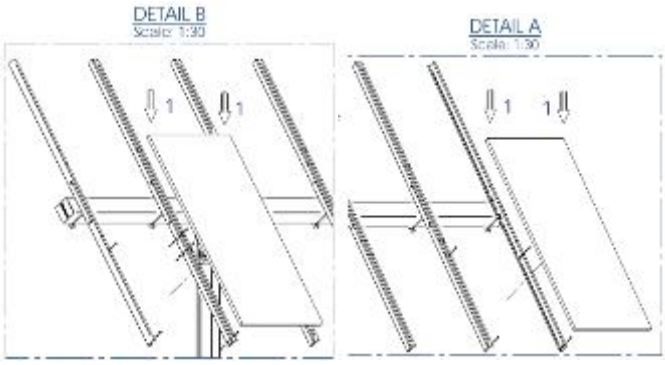


Use of the template for the purlin's assembly

4.5. Module assembly



1

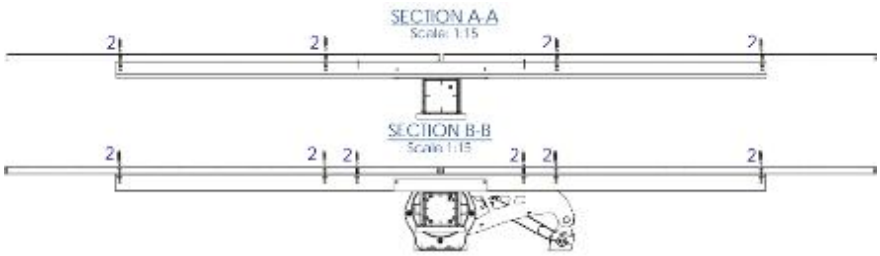


Set the modules on the adjacent purlins, previously assembled.

Assembly will preferably start from one end of the tracker to the other.

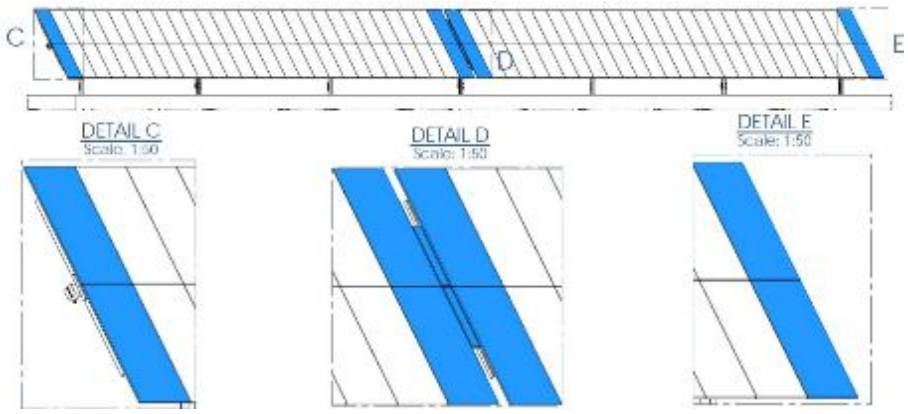
(*) Note: Ensure the torque tube is at a right angle (90°) with the purlin (this needs to be dine with the tracker at a horizontal position -0°) before starting the assembly of the modules

2



Modules are screwed to the purlins (Ω or C).

3



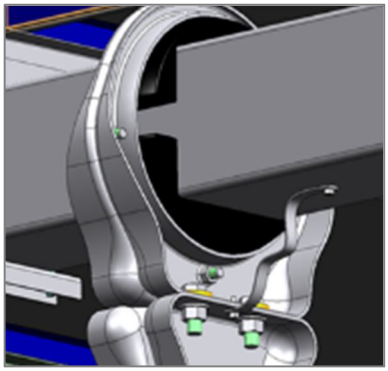
For a correct alignment, first the end modules (from the bottom) will be aligned with the Self-Powered Module (from the top). The rest of the modules will then be assembled aligned with the previous ones.

Assembled modules

4.6. Tracker electrical continuity

Install grounding straps with the self-drilling screws (Torque 2 Nm). These straps aim to guarantee electrical continuity between modules and piles.

1



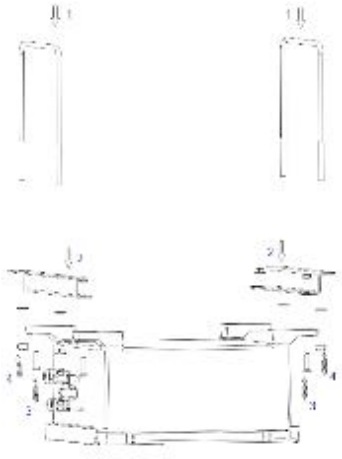
One end of the grounding strap is attached to the tube, using a self-drilling screw DIN 7504K 6.3x19.

2

The other end of the Grounding Strap is fixed to the Lower Bearing Support with a self-drilling screw DIN 7504K 6.3x19.

4.7. Tracker control unit (TCU) assembly

Mechanical assembly:

1	2	3	4
			
Insert the U-bolts around the torque tube. The distance and spacing from the motor pile and motorized actuator is specified in *[General floor and elevation drawing – GFED - Detail B]*.	**Place the TCU supports on the TCU.**	**Install the hardware to connect the TCU to the TCU supports.**	**Tighten the hardware that connects the TCU set to the TCU support with the U-bolts**

Electric assembly:

1. Self-Powered systems

   - Connection of the Self-Powered system to the (TCU) will be done according to ***[TCU Assembly Manual]***
   - Connections of the TCU to the Antenna and the Actuator Motor will be done according to ***[TCU Assembly Manual]***

2. Powered systems

   - The supply to the Electrical Panel (TCU) according to ***[TCU Assembly Manual]***
   - Connections of the Electrical Panel (TCU) to the Antenna and the Actuator Motor according to ***[TCU Assembly Manual]***

(*) Note: The wiring will be installed along the torsion axis according to the electrical configuration of the tracker to avoid overloads not considered in the design.

4.8. Anemometer tower and other sensors assembly

[Anemometer drawing – AD]

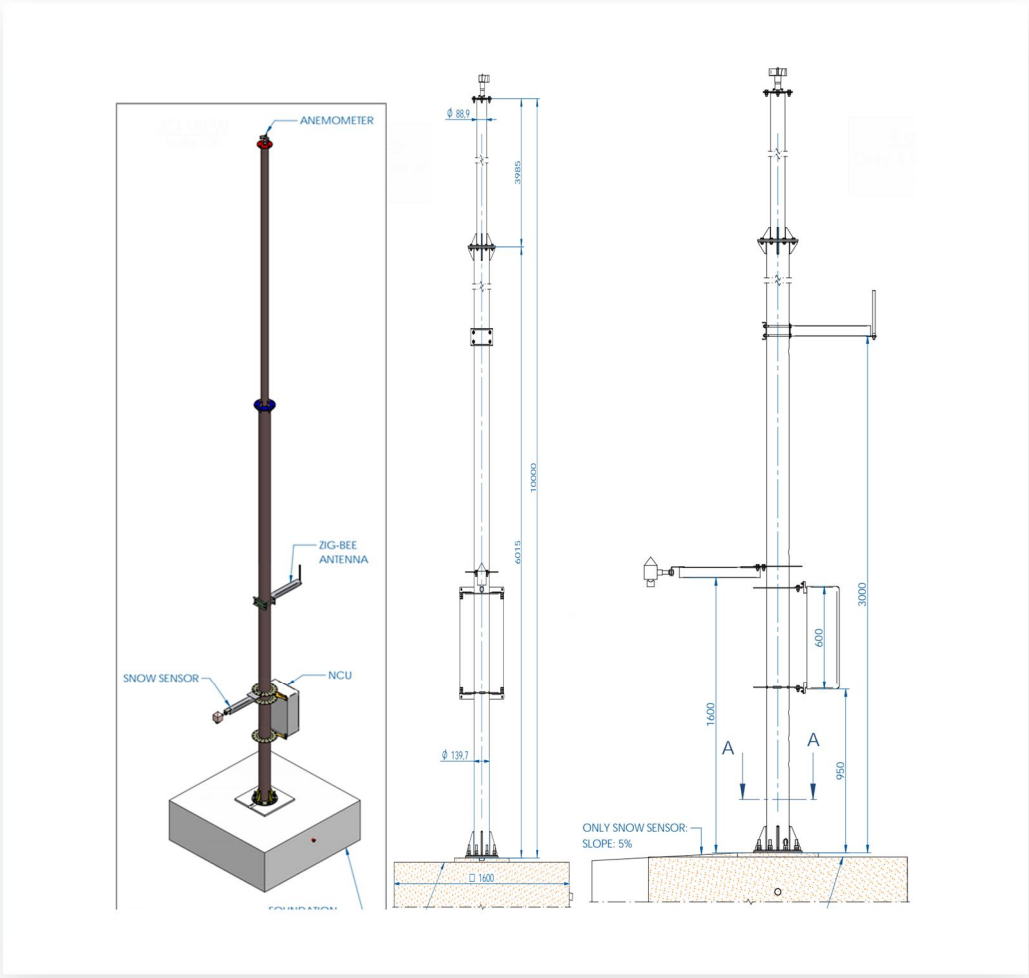
[Anemometer foundations drawing – COMN-CMM10]

(*) Note: The anemometer support will be placed higher than the PV modules of the trackers. The design height of Trina Tracker anemometers is generally 10 m.

If a lower height is required, contact the technical staff of Trina Tracker.

The anemometer will be in an area free of obstacles for wind speed data accuracy and reliability.

The anemometer will be located on site so that it does not cast a shadow on the PV modules. This is either specified in the drawing by Trina Tracker or requested by the customer.



4.9. Network control unit (NCU) assembly

The NCUs are delivered pre-integrated with all of their electrical components. Only the power, communication and peripheral wiring should be connected, the scope of which is not the responsibility of Trina Tracker and must be carried out according to ***[NCUs Installation manual]***.

Assembly sequence

1. The NCUs need to be installed at the base of the anemometer tower at the height indicated in the ***[Anemometer drawings – AD]***, with the supports supplied by Trina Tracker.

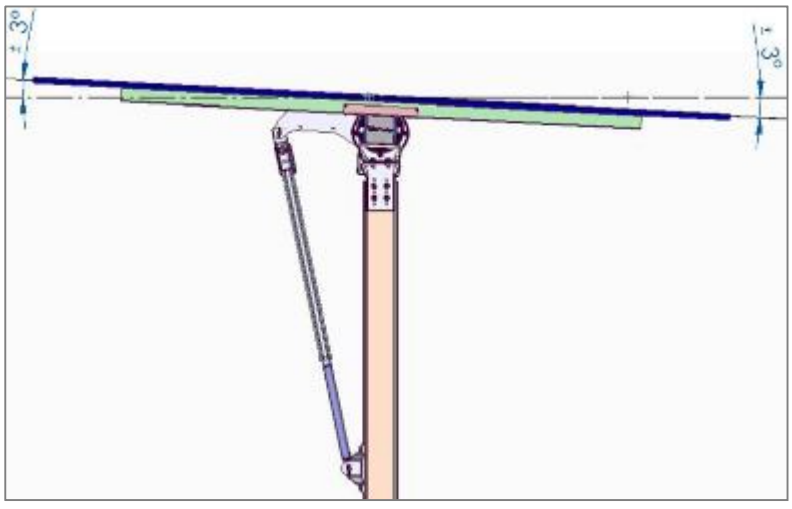
2. Perform The installation and connection of the wiring sensor (generally wind and snow) to the (NCU) according to ***[NCU installation Manual]***.

(*) The wiring must avoid sharp edges to protect the cable insulation and must have adequate slack.

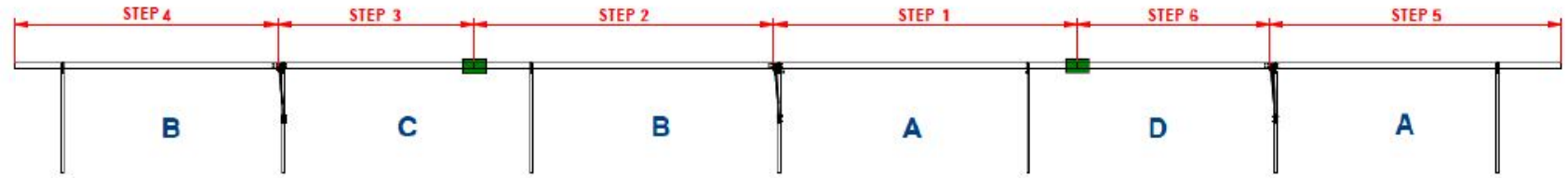
If the NCUs need to be located separately from the anemometer, contact your Trina Tracker representative. The cable run for the connection of the anemometer tower and the NCU is not included.

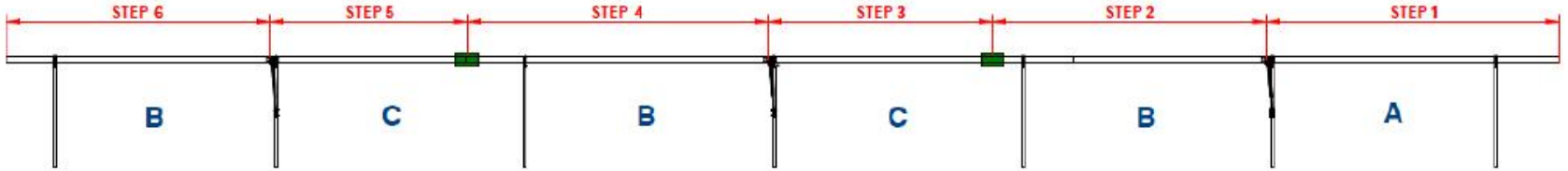
Any modification in the electrical configuration of the Tracker must be notified to the Trina Tracker technical staff, for technical validation, as it may have an impact on commissioning.

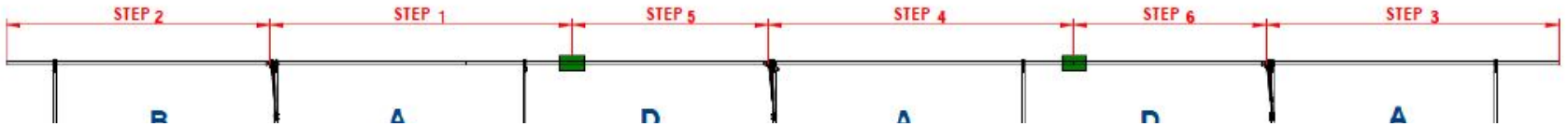
Module alignment tolerance is +/- 3° between the modules on both sides of the tracker, as shown below:

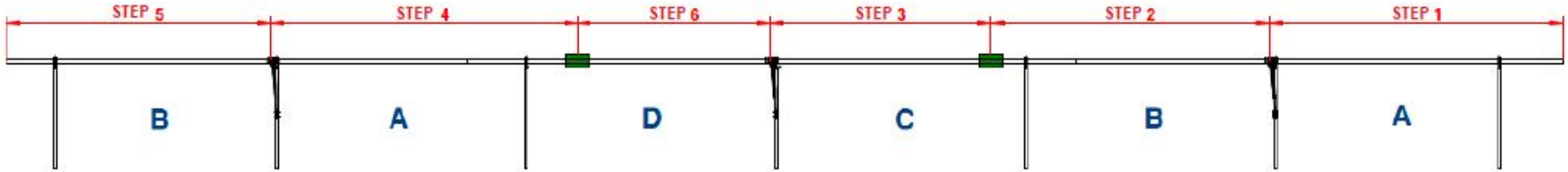


Different TYPES catalogue that can be found by Configurations and Steps to follow in the installation of VANGUARD Inner/Border Tracker

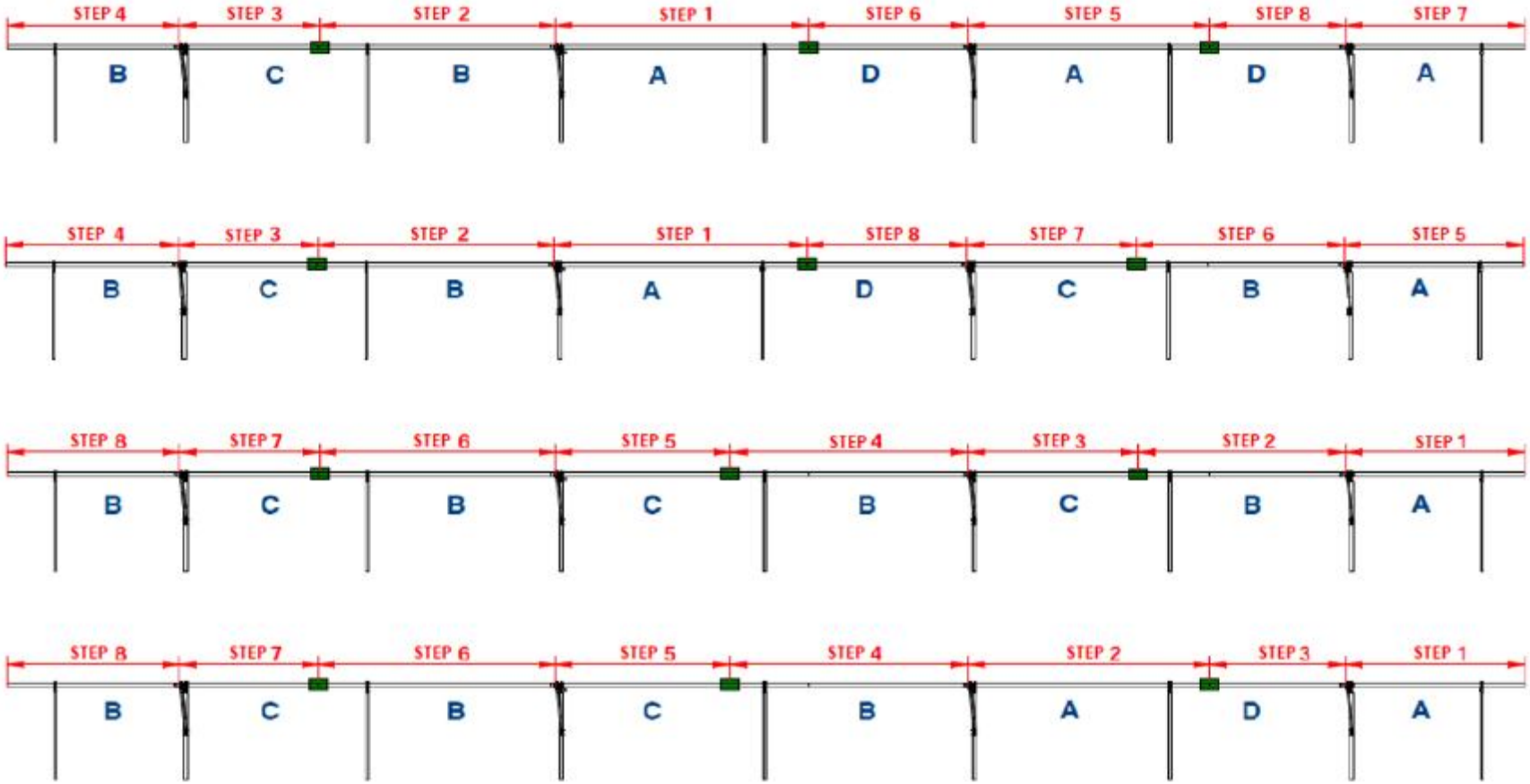


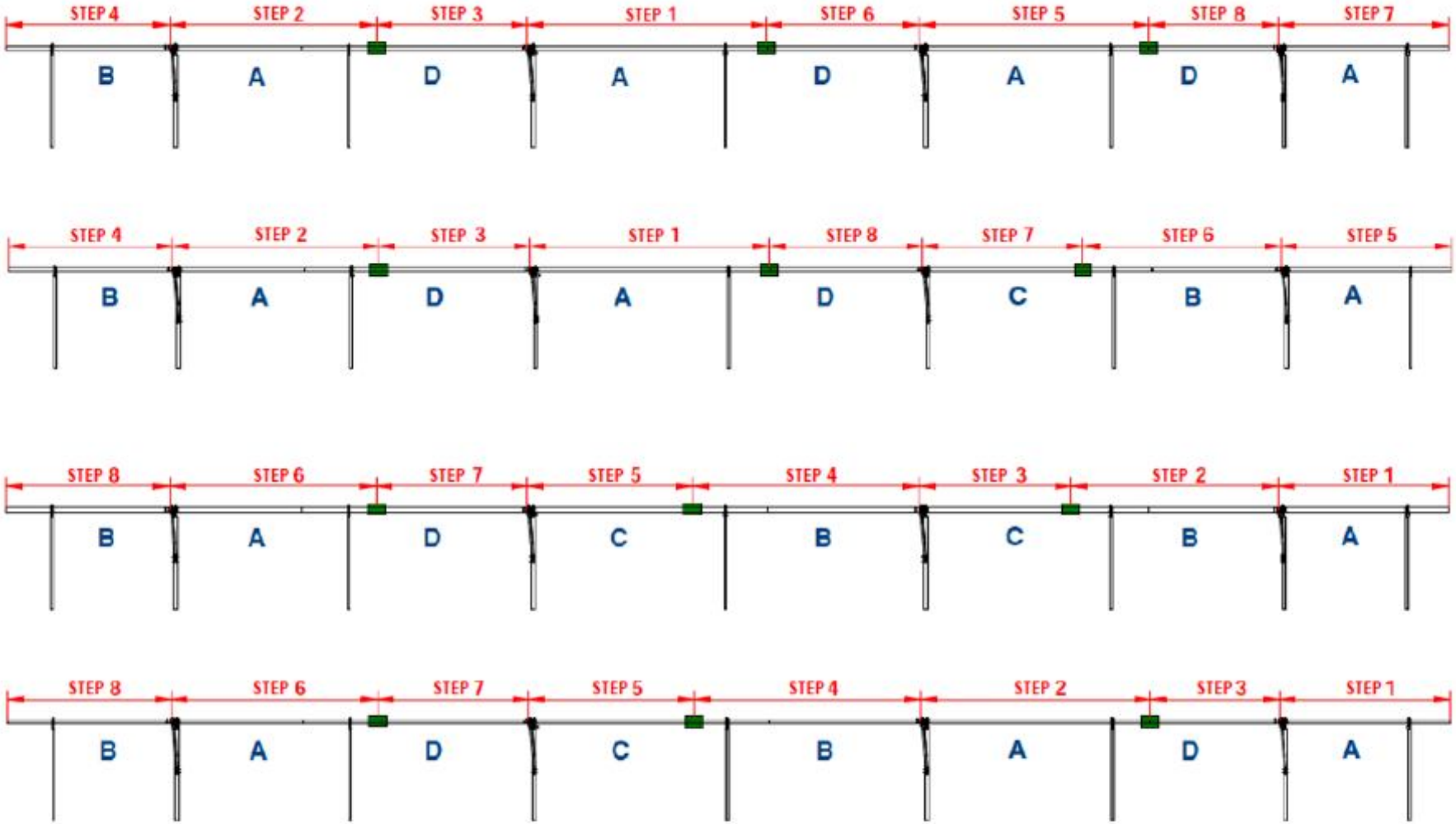






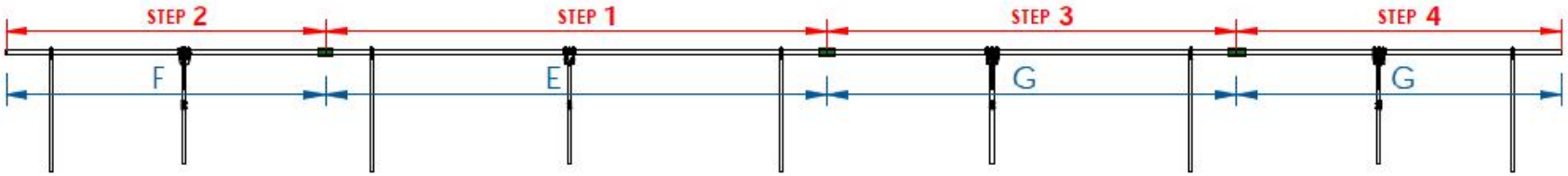
Different TYPES catalogue that can be found by Configurations and Steps to follow in the installation of VANGUARD 2nd row Outer

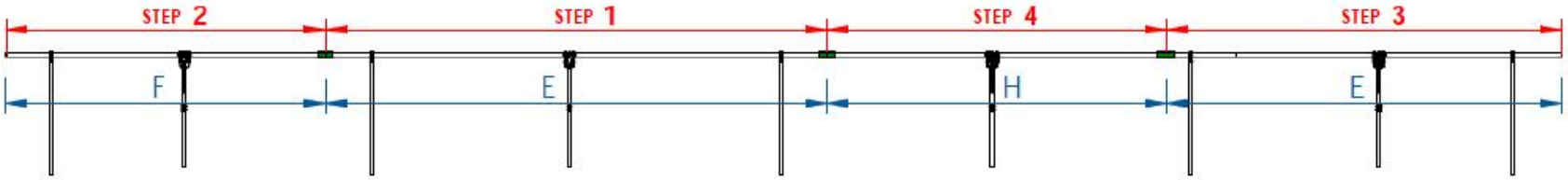


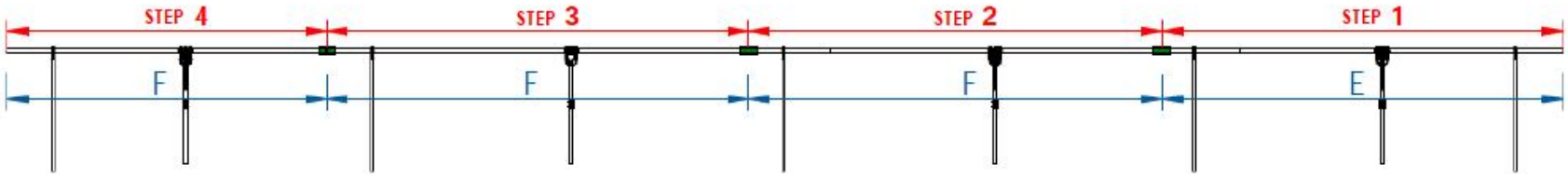

STEP 4
STEP 2
STEP 3
STEP 1
STEP 6
STEP 5
STEP 8
STEP 7
B A D A D A D A
STEP 4
STEP 2
STEP 3
STEP 1
STEP 8
STEP 7
STEP 6
STEP 5
B A D A D C B A
STEP 8
STEP 6
STEP 7
STEP 5
STEP 4
STEP 3
STEP 2
STEP 1
B A D C B C B A
STEP 8
STEP 6
STEP 7
STEP 5
STEP 4
STEP 2
STEP 3
STEP 1
B A D C B A D A

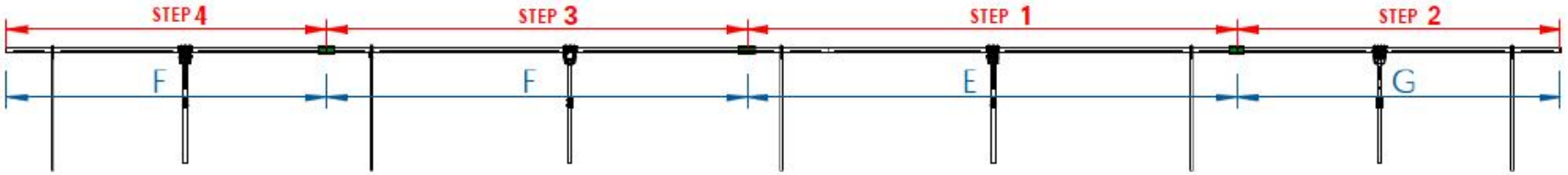
Different TYPES catalogue that can be found by Configurations and Steps to follow in the installation of VANGUARD

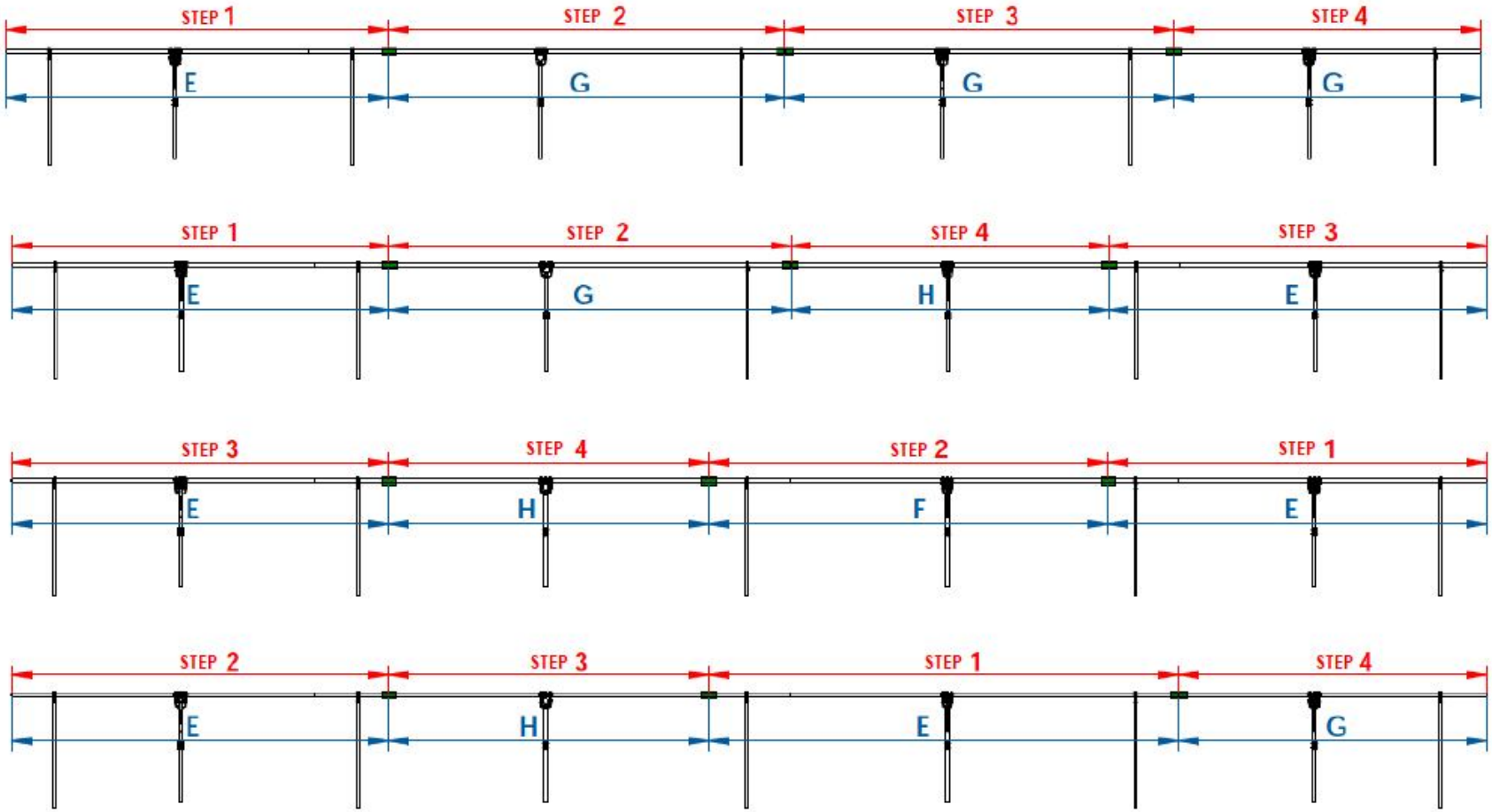
1st row Outer







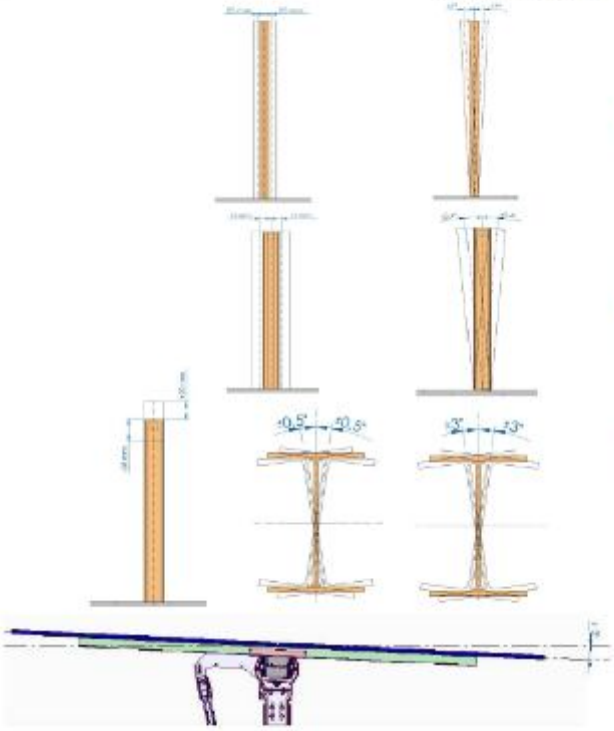



STEP 1
STEP 2
STEP 3
STEP 4
E
G
G
G
STEP 1
STEP 2
STEP 4
STEP 3
E
G
H
E
STEP 3
STEP 4
STEP 2
STEP 1
E
H
F
E
STEP 2
STEP 3
STEP 1
STEP 4
E
H
E
G

*Client's Logo

CHECK LIST TRACKER VANGUARD

VISUAL/TOLERANCE



X = ± 25mm (1 inch) in piles.

Pile inclination in N/S direction must be equal or less than β = ± 1°.

X = ± 15mm (5/8 inches) in piles.

Pile inclination in E/W direction must be equal or less than β = ± 0,4°.

Maximum tolerance in the upper section of the pile: ±20 mm (3/4 inches).

Twisting in Standard Piles: ±3°
Twisting in Motor Piles: ±0.5°

Module alignment ≈ ±3° α

VISUAL FOR COMPONENTS AND STRUCTURE/TRACKER

ASPECTS TO CONSIDER

The tracker is with all the elements (electrical parts included)
All elements are mounted according to the assembly manual
Absence of damaged assembled elements
Coating Paint
Absence of interference on trackers movement

VISUAL FOR COMPONENTS AND STRUCTURE/TRACKER

ASPECTS TO CONSIDER

The tracker is with all the elements (electrical parts included)
All elements are mounted according to the assembly manual
Absence of damaged assembled elements
Coating Paint
Absence of interference on trackers movement

TIGHTENING TORQUE

TIGHTENING TORQUE

	REFERENCIE	Calidad 8.8	Advisable wrenches
1	M8 (ROUSS)	4.4	Dynamometric wrench (Torque: 6Nm - 50Nm)
2	M8 (Non contact joints)	17	Dynamometric wrench (Torque: 6Nm - 50Nm)
3	M10 (Non contact joints)	20	Dynamometric wrench (Torque: 20Nm - 80Nm)
4	M10 (Nuts Purlin - Tube joint)	30	Dynamometric wrench (Torque: 20Nm - 80Nm)
5	M12 (Rigid joints)	77	Dynamometric wrench (Torque: 70Nm - 500Nm)
6	M16 (Rigid joints)	190	Dynamometric wrench (Torque: 70Nm - 500Nm)

Rigid joints are defined when connected pieces are in contact, or the separation between them is so small that after tightening to the correct torque they are totally in contact

→ Tightening Torque Tolerance for Rigid Unions must be ±10%

Non-Contact joints are defined when the connected pieces are not in contact after tightening to the correct torque. In this case, if they are tightened excessively, they could break or deform

→ Tightening Torque for Non-contact Joints must be +0/-10%

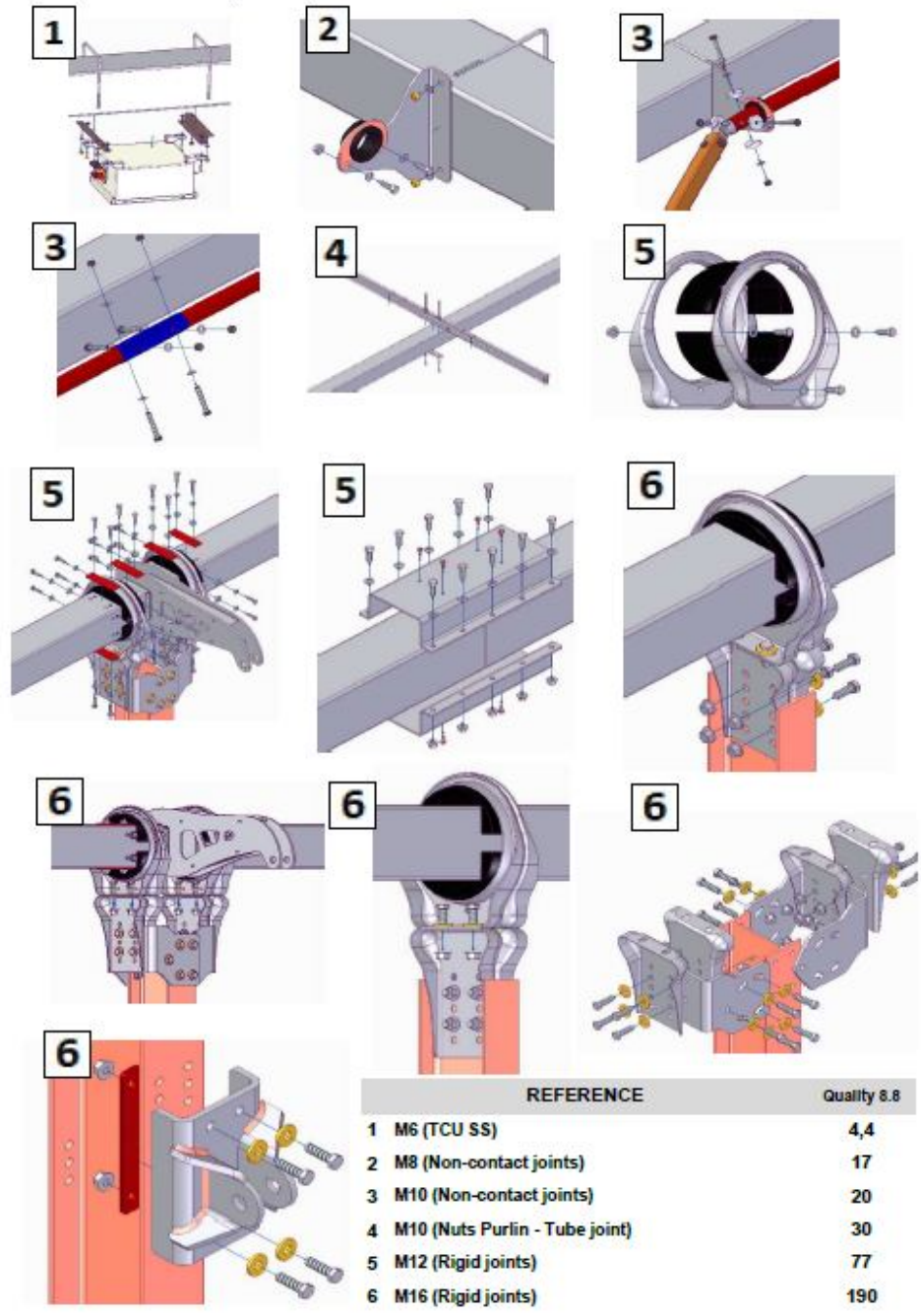
*Client's Logo

CHECK LIST TRACKER
VANGUARD

TrinaTracker

TIGHTENING TORQUE

TIGHTENING TORQUE LOCATOR



	REFERENCE	Quality 8.8
1	M6 (TCU SS)	4,4
2	M8 (Non-contact joints)	17
3	M10 (Non-contact joints)	20
4	M10 (Nuts Purlin - Tube joint)	30
5	M12 (Rigid joints)	77
6	M16 (Rigid joints)	190

Client's Logo	CHECK LIST TRACKER VANGUARD	TrinaTracker

The screws shall be tightened following bolt tightening procedure:

1 Pre-tighten the bolts to 75% of the torque level according to the tightening toque table above, starting with the top screws and then the bottom screws, crosswise. The tighten shall be done mechanically (with torque wrench) or manually, in both cases using calibrated impact head tools with the purpose of preventing any form of erosion on the edges of the screw due to wear on the head. The tool head shall be replaced when damage is detected on the edges of the screw.

2 Final tightening: Calibrated and certified torque wrench shall be used to apply the specified tightening torque within tolerances as referenced above. Once the torque is applied, is mandatory that the bolt shall be marked with permanent marker.

Do not proceed to step 2 until step 1 has been applied in all the screws in the joint. Bear in mind, symmetrical joints have their own specific tighten sequence.

This system will only work correctly if the nut remains stationary whilst the bolt is tightened, so that the grooves grip and hold the parts together.