

Comune di Carbonia-Iglesias

Provincia di Sud Sardegna

Descrizione:

PROGETTO DEFINITIVO

Oggetto:

REALIZZAZIONE IMPIANTO FOTOVOLTAICO DI POTENZA DC 6.342.30 kWp E
POTENZA IN IMMISSIONE PARI A 4.900 kW (AC)

Elaborato:

DETTAGLI MECCANICI TRACKER MONOASSIALI

Disegnato:

M.I.

Controllato:

D.C.

Rilasciato:

D.T.

tel: 045 8088911

fax: 045 581254

e-mail: info@mannienergy.it

Tavola:

Scala:

varie @A1

Codice:

REL_07

Data:

06-2021

Nome file:

Percorso file:

Rev:

Data:

Descrizione:

00

06-2021

Emissione per approvazione

01

02

.....

.....

Commessa:

4961_Carbonia

Progettazione:

Committente:

Indirizzo cantiere:

Loc. Acquas Derettas
Carbonia-Iglesias (SU)

Il Progettista:



MANNI ENERGY
ENERGY SOLUTIONS

PREMESSA

L'impianto fotovoltaico in esame, denominato CARBONIA, sarà costituito da N° 11.745 moduli fotovoltaici in silicio policristallino 72 celle da 540W/cad. disposti su N° 435 supporti dedicati orientabili (tracker monoassiali), orientabili a +/- 50°. Si tratta di strutture innovative caratterizzate da un inseguitore monoassiale che orienta i moduli in funzione della posizione del sole, garantendo così un aumento della producibilità di oltre il 30%.

I tracker monoassiali sono costituiti da strutture a telaio metallico, in acciaio zincato a caldo, costituito da pali infissi nel terreno e da una trave di collegamento superiore rotante ove sono fissati i pannelli fotovoltaici. Non sono pertanto previste fondazioni in calcestruzzo o di tipo invasivo.

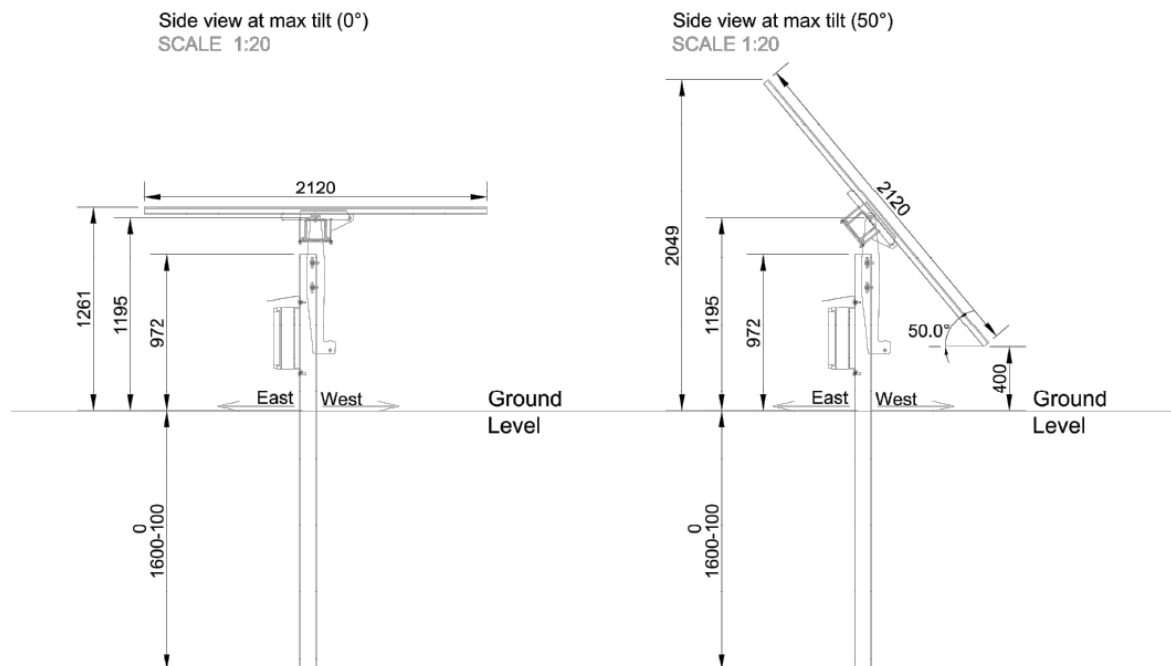
Le strutture sono dimensionate per supportare i carichi trasmessi dai pannelli e le sollecitazioni esterne a cui sono sottoposti (vento, neve,.....). Tali strutture innovative, utilizzano il sistema di backtracking che controlla e assicura che una serie di pannelli non ombreggi gli altri pannelli adiacenti quando l'angolo di elevazione del sole è basso nel cielo, all'inizio o alla fine della giornata. L'auto-ombreggiamento automatico tra le file dei tracker potrebbe, infatti, potenzialmente ridurre l'output del sistema (produzione globale annuale).

Per l'impianto in oggetto verranno utilizzati i tracker ad inseguimento monoassiale. La configurazione della struttura tracker è: 1 fila x 27 pannelli/cad. in disposizione verticale, secondo le dimensioni sotto riportate

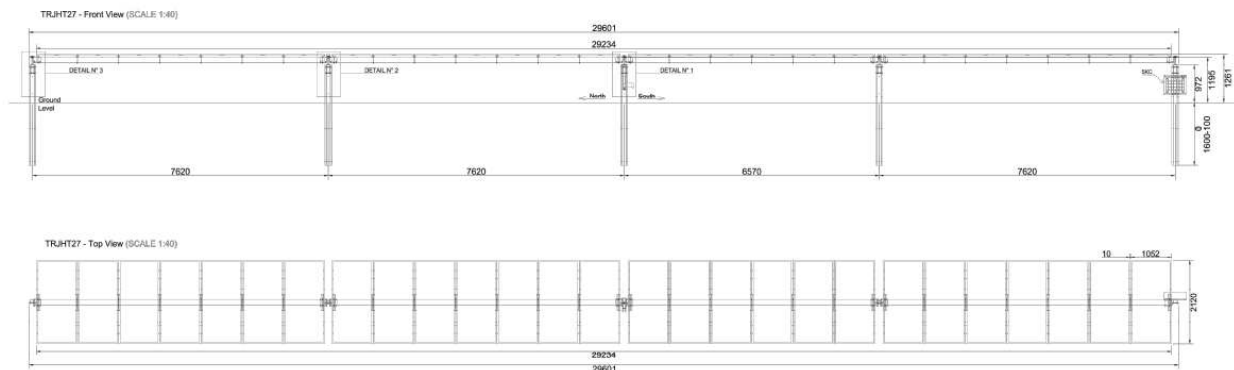
MANNI ENERGY S.r.l.

Sede Legale e Operativa: Via Augusto Righi, 7 | 37135 Verona | ITALY | T. +39 045 8088911 | F. +39 045 581254
Sede Operativa: Strada Provinciale Morlense, Z.I. | 03010 Patrica (FR) Italy | T +39 0775 2081

REA VR 381548
P.IVA / C.F. 03979550237
Cap. Soc. € 3.000.000,00 i.v.
www.mannienergy.it | info@mannienergy.it



DIMENSIONI INSEGUITORI MONOASSIALI: VISTA LATERALE SOGGETTA A VERIFICA GEOTECNICA DEL SITO



DIMENSIONI INSEGUITORI MONOASSIALI: VISTA DALL'ALTO E LATERALE

Ogni fila è dotata di un attuatore lineare e un clinometro elettronico. L'attuatore lineare viene mosso da un motore 12 Vdc con un assorbimento di corrente di 10 A. Il motore è un motore a corrente continua ad alta efficienza, a basso riscaldamento, senza condensatore elettrolitico.

MANNI ENERGY S.r.l.

Sede Legale e Operativa: Via Augusto Righi, 7 | 37135 Verona | ITALY | T. +39 045 8088911 | F. +39 045 581254

Sede Operativa: Strada Provinciale Morlense, Z.I. | 03010 Patrica (FR) Italy | T +39 0775 2081

REA VR 381546

P.IVA / C.F. 03979550237

Cap. Soc. € 3.000.000,00 i.v.

www.mannienenergy.it | info@mannienenergy.it

Direzione e coordinamento: MANNI GROUP S.p.A | P.IVA e C.F. 02960130231

Nella versione cablata, l'alimentazione del tracker è monofase 230 AC. La classe di isolamento è: Classe II.

Il controllo del dispositivo elettronico, è una scheda elettronica protetta da una scatola di materiale resistente ai raggi UV, grado IP 65. Ogni unità di controllo è concepita per gestire 4 tracker. I tracker lavorano tramite un algoritmo che fornisce una fase di backtracking mattutino da 0° a + 50° e analogamente a fase di backtracking serale da -50° a 0°. Il sistema calcola l'angolo ottimale evitando l'ombreggiatura dei pannelli. Durante la fase centrale "Tracking Diretto" da + 50 ° a -50 °, il sistema insegue l'angolo ottimale per il tracker con un errore massimo uguale al valore impostato. Il controllo opera per preservare la vita delle spazzole del motore e la vita dei relè e garantire il numero di fermate necessarie durante la vita utile dell'impianto. È possibile modificare e impostare i parametri di controllo per adattare il sistema alle caratteristiche del sito locale e per ottimizzare la produzione di energia solare. La soluzione di supporto per la posizione dell'attuatore è realizzata con boccia in bronzo a basso attrito, fissata da dadi su un supporto in acciaio. I perni di rotazione sono realizzati in acciaio inossidabile. L'accoppiamento dei materiali è esente da corrosione elettrochimica. La soluzione costruttiva della struttura del tracker consente l'installazione su un suolo con pendenza al 10%, l'asse di rotazione è molto vicino all'asse del baricentro della struttura. Ciò consente di ridurre la coppia sulla struttura e il carico sull'attuatore. Il dimensionamento torsionale della struttura è realizzato al fine di evitare fenomeni di instabilità dovuti all'aumento del coefficiente "fattore di forma".

- Il materiale dei poli è acciaio S 355 JR
- Il materiale della parte di giunzione e del supporto del cuscinetto è in acciaio S 355 JR e S 275 JR
- Il materiale del tubo è S 275 JR
- Per gli arcarecci il materiale è acciaio S 235 JR
- Installazione Tolleranza verticale +/- 20 mm
- Installazione Tolleranza orizzontale +/- 30 mm

MANNI ENERGY S.r.l.

Sede Legale e Operativa: Via Augusto Righi, 7 | 37135 Verona | ITALY | T. +39 045 8088911 | F. +39 045 581254
Sede Operativa: Strada Provinciale Morlense, Z.I. | 03010 Patrica (FR) Italy | T +39 0775 2081

REA VR 381546
P.IVA / C.F. 03979550237
Cap. Soc. € 3.000.000,00 i.v.

www.mannienenergy.it | info@mannienenergy.it

Direzione e coordinamento: MANNI GROUP S.p.A | P.IVA e C.F. 02960130231

La protezione superficiale avviene mediante zincatura a caldo secondo la norma UNI-EN-ISO1461, con spessore rivestimento di zinco 55 µm. La categoria di corrosione ambientale è C2 con riduzione spessore massimo di zinco di 0,7 µm / anno. Con questa riduzione dello spessore la durata prevista è di $55 / 0,7 = 78$ anni.

Il fissaggio dei pannelli fotovoltaici viene eseguito con rivetti in acciaio inossidabile e rondella in acciaio inossidabile per evitare fenomeni di corrosione. Le fondazioni sono realizzate con sistema di martellatura o, dove non possibile, preforatura + martellatura. I pali sono realizzati in acciaio S 355 JR più adatto per essere martellato senza deformazioni, la profondità delle fondamenta è di circa 1.5m, dato comunque soggetto a verifica a seguito delle indagini geotecniche del sito.

Di seguito viene proposto il documento tecnico redatto a cura del Produttore, intitolato: “PI1030PEMN0010B- Tracker-Installation Manual - TRJ27 “

CONVERT TRJ

HORIZONTAL SINGLE AXIS TRACKER



TRACKER - INSTALLATION MANUAL

MODEL TYPE:
TRJ 27 MODULES

MANNI_CIVITAVECCHIA

PI1036PEMN0010B

© COPYRIGHT Convert Italia S.p.A.

All rights reserved.

CONVERT Italia S.p.A. has proprietary rights on this document, which must not be used for any purpose other than that for which it is supplied and must not be reproduced without permission from the owners.

REVISIONS			
N.	DATE	PAG./SECT.	NOTES
0A	13/04/2021		FIRST ISSUED
0B	22/04/2021		Add details

PREPARED	CHECKED	APPROVED
Name: Roberto BIAGI Date: 13/04/2021	Name: Andrea RICCI Date: 13/04/2021	Name: Andrea RICCI Date: 13/04/2021

SYMBOLS USED IN THE HANDBOOK

	<p>GLOVES OBLIGATION</p> <p>The presence of this symbol requires the use of electrical/thermal insulation by the operator.</p>
	<p>SAFETY FOOTWEAR OBLIGATION</p> <p>The presence of this symbol requires the use of the proper safety footwear by the operator.</p>
	<p>GENERAL DANGER</p> <p>The presence of this symbol requires a particular attention from the operator.</p>
	<p>DANGER OF ELECTROCUTION</p> <p>The presence of this symbol indicates to the operator that the illustrated operation presents, if not properly executed in compliance with the safety regulations, the risk of an electric shock.</p>
	<p>DANGER OF LIFT TRUCKS MOVING</p> <p>The presence of this symbol indicates to the operator the risk of danger about the vehicles moving next to TRJ.</p>
	<p>DANGER OF CRUSHING</p> <p>The presence of this symbol indicates to the operator that the illustrated operation presents the risk of hand injury because of crushing.</p>

TABLE OF CONTENTS

SYMBOLS USED IN THE HANDBOOK	3
TABLE OF CONTENTS	4
1. DESCRIPTION OF THE PRODUCT	6
INTRODUCTION	6
MAIN CHARACTERISTICS	6
2. TECHNICAL SPECIFICATIONS	7
GENERAL SPECIFICATIONS	7
ELECTRICAL SPECIFICATIONS	8
OTHER CHARACTERISTICS	9
3. SAFETY AND REGULATIONS	10
ENVIRONMENT	10
4. INSTRUCTIONS FOR INSTALLATION	11
MECHANICAL KIT COMPONENTS FOR TRACKER MOVEMENT	11
MAIN MECHANICAL STANDARD COMPONENTS	14
BOLTS AND NUTS ASSEMBLY FOR KIT COMPONENTS	15
QUANTITIES OF MECHANICAL COMPONENTS PER AXIS	16
EQUIPMENT	16
LIST REFERENCE PROJECT DOCUMENTS	18
OVERALL PROCEDURE	18
OMEGA PILES POSITIONING	19
CENTRAL, MIDDLE AND END PILE HEAD ASSEMBLY	24
PILE HEAD ASSEMBLY	22
PILE HEAD ALIGNMENT	27
REGULATION OF CENTRAL PILE HEAD AND SHARED PILE HEAD	27
CENTRAL SADDLE ASSEMBLY	31
MIDDLE SADDLE ASSEMBLY	32
END SADDLE ASSEMBLY	33
MAIN BEAM AND TIE ASSEMBLY	34
LINEAR ACTUATOR ASSEMBLY	38
LINEAR ACTUATOR AT = 0°	43
5. SKC CONTROL BOX WIRING	44

ACTUATOR WIRING	46
SKC POWER CABLE	47
6. TEST PROCEDURES	48
INSTRUMENTATION , EQUIPMENT AND NECESSARY DOCUMENTATION.....	48
INSPECTION AND EQUIPMENT PRELIMINARY CHECKS	48
MECHANICAL TEST PROCEDURE	48
ELECTRICAL TESTING PROCEDURE.....	48
TRACKER MOTION TEST PROCEDURE	48
7. ANNEX INDEX.....	49
A - MODULE SUPPORTS ASSEMBLY	50
B - SKC MECHANICAL ASSEMBLY.....	56
C - ANEMOMETER, GPS MECCANICAL ASSEMBLY	62
D - WIRELESS SYSTEM ASSEMBLY	67
E – ZINC RENOVATION ON DAMAGED PILES.....	72

1. DESCRIPTION OF THE PRODUCT

INTRODUCTION

The TRJ single axis tracker has been conceived with the aim of combining the simplicity of installation and maintenance of a ground fixed plant with the advantages given by a solar tracker related to the energy increase.

The operation of a single axis, tilt 0°, tracker is based on the movement of photovoltaic modules on a single North-South axis, so as to automatically track the sun's East-West movement during the day.

MAIN CHARACTERISTICS

The tracker consisting of 2 separate sets:

- **KIT:** containing the movement components (pile heads, saddles, ties, actuators and electronic control boxes)
- **STANDARD:** containing steel profiles (main beams, omega piles and module supports for photovoltaic modules)

The KIT assembly contains owner solutions with the high reliability and efficiency that allow the movement of the tracker and is always provided by Convert Italia SpA.

The STANDARD assembly uses materials easy to find, meeting the local content requirements imposed by various countries.

2. TECHNICAL SPECIFICATIONS

GENERAL SPECIFICATIONS

The following technical specifications are referred to TRJ product in its standard configuration with crystalline modules.

TRACKING TYPE	Single -Axis, 0° Tilt		
TRACKING ANGLE	±30 °		
CONTROL TYPE	Microcontroller with astronomical clock		
TRACKING ERROR	±2°		
MATERIAL	Hot Dip Galvanized Structural Steel and Continuously Hot Dip Coated Structural Steel		
ROTATION JOINT	Self-lubricating spherical bearings (maintenance free)		
HANDLING EQUIPMENT	Linear Actuator : 230 V~ 50-60 Hz (CE mark) Stroke 370mm		
MECHANICAL INSTALLATION TOLERANCES	+/- 20 mm height	±2° tilt pile	±5° twist pile
OPERATING TEMPERATURE	From -10°C to +50°C		

ELECTRICAL SPECIFICATIONS

The axes are driven by AC electric linear actuators. One control box can control up to 10 linear actuators, moving 2 actuators at the same time by means of 2 starting capacitors integrated in the box.

The control box has the following features:

POWER SUPPLY for SKC	Voltage: 230 VAC $\pm 10\%$ (500 - 1500 Vdc with self power option) Frequency: 50-60 Hz $\pm 5\%$ Type: 1 P + N + G Nominal electrical absorption: 2 A (1 A with self power option) Power Factor: 0,4÷1 Over- voltage protection, Differential Protection : 2,5 kA – 50 J and common mode (5 kA) Breaker Protection: 5 kA (optional with Self Power Module)
OUT	10 channels for the control of brushless AC actuators.
IN	20 free voltage contacts for the control of the limit switch and encoder Protection from overvoltage 40 A – 400 W – Wave 10/1000 μ s electric insulation 890V
ALARMS	Output with 5 A free voltage contact and 4 kV insulation Status signaling through 3 internal LED Failure warning signal (external red light) Integrated buzzer
COMMUNICATION PROTOCOL RS485	Overvoltage protection 100A – Wave form 10/1000 μ s MODBUS Communication Protocol 4800 bps 8n2 In case of wireless option: 57600 bps 8n1
COMMUNICATION PROTOCOL RS232	Local user interface via PC DB9 connector USB PC connection Protection from overvoltage 120A – 0,2J Software configuration in MS-Windows (only for service)
OTHER CHARACTERISTICS	Microcontroller 32bit 100 MHz 512 KB FLASH Static control of actuators (SSR) Automatic restart after power failures Integrated button for manual control of the actuators (East-West moving) Additional cover for protection from weather events Integrated starting capacitor MTBF 2.000.000 hours of the electronic control box
MECHANICAL CHARACTERISTICS	Provided with a support plate for the connection to tracker pile IP55 Protection
ENVIRONMENTAL CHARACTERISTICS	Operating Temperature -10°C ÷ + 50°C Natural convection passive cooling

OTHER CHARACTERISTICS

- In compliance with 2006/42/EC Directive of European Parliament and Council dated May 17 2006 related to machines
- CE mark
- PD2012A00174 Patent

3. SAFETY AND REGULATIONS

1993/68/EEC Directive of Council of the European Communities dated July 22nd, 1993 and related to CE marking

2006/42/CE Directive of European Parliament dated may 17th, 2006 related to machines

2006/95/CE Directive on the approximation of the laws of the Member States relating to electrical equipment intended to be used within certain voltage limits


2004/108/CE Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility

2012/19/UE RAEE Directive related to the waste of electrical and electronic equipment Identification Label

ENVIRONMENT

The disposal of the product is essential to prevent potential negative consequences for the environment and health. This issue will be pursued basing on local directives.



The symbol  on the product, packaging or documentation, indicates that it will not be treated as household waste. The product must be delivered to a central collection point for the recycling of electrical and electronic equipment. It is important to dispose of the product in compliance with local environmental waste regulations.

For more information on disposal, recycling and re-use of the product, it is necessary to address to local authorities, the local waste collection service or the dealer/company from whom you have purchased the product.

The packaging, designed to protect the tracker and its components during the transport, must be delivered to a collection center.

4. INSTRUCTIONS FOR INSTALLATION

MECHANICAL KIT COMPONENTS FOR TRACKER MOVEMENT



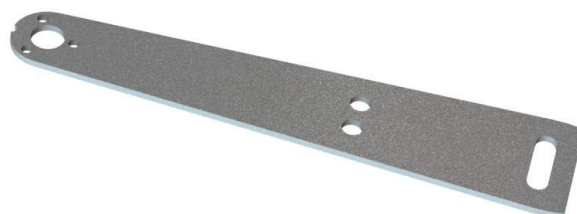
A1 RIGHT CENTRAL PRESSFORMED PLATE



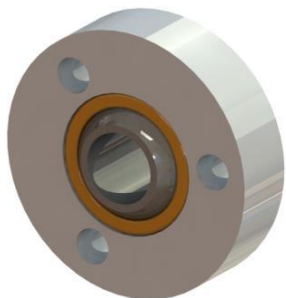
A2 LEFT CENTRAL PRESSFORMED PLATE



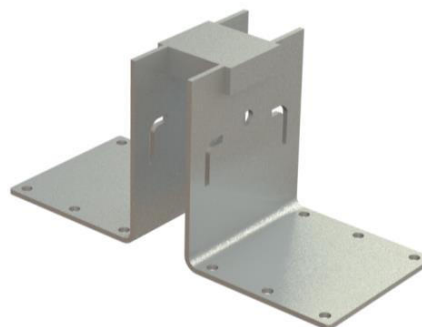
B1 MIDDLE PRESSFORMED PLATE



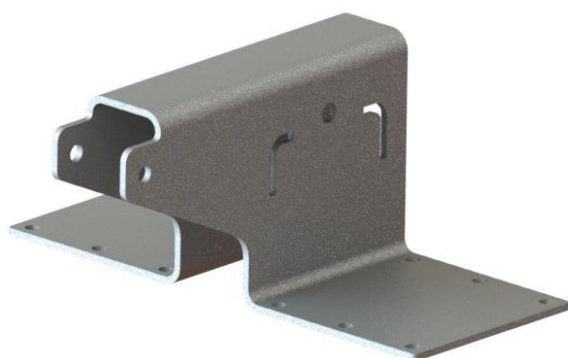
B2 END STRAIGHT PLATE



AB SPHERICAL BEARING



C MIDDLE SADDLE



D CENTRAL SADDLE



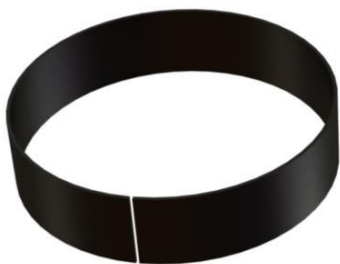
E END SADDLE



F LINEAR ACTUATOR

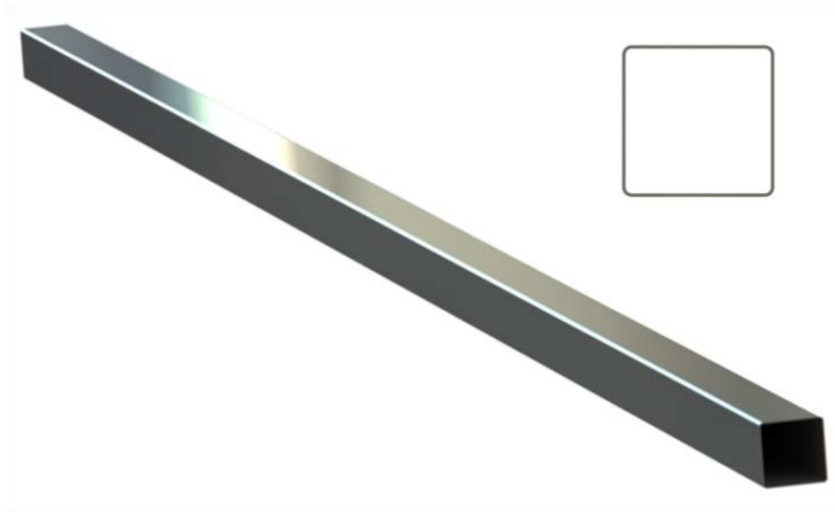


G TIE



C1 METALLIC TIE

MAIN MECHANICAL STANDARD COMPONENTS



N' MAIN BEAM 7m

N'' MAIN BEAM 6m



O' CENTRAL OMEGA PILE

O'' LATERAL OMEGA PILE



BOLTS AND NUTS ASSEMBLY FOR KIT COMPONENTS

H MOUNTING BOLTS KIT

SADDLE - PILE HEAD

1X SCREW M16 L=100 DIN 931
 1X NUT M16 DIN 934-8
 1X WASHERS M16 DIN 125
 2X SPACERS FOR M16



I MOUNTING BOLTS KIT

TOP ACTUATOR -

CENTRAL SADDLE

1X LONG SCREW M14 L=100 DIN 931
 1X NUT M14 self locking DIN 982
 1X WASHERS M14 DIN 125
 2X LONG SPACERS FOR M14



J MOUNTING BOLTS KIT

BOTTOM ACTUATOR - CENTRAL PILE HEAD

1X SHORT SCREW M14 L= 75
 1X NUT M14 self locking DIN 982
 1X WASHERS M14 DIN 125
 2X SHORT SPACERS FOR M14



K MOUNTING BOLTS KIT

TIE - MIDDLE AND END SADDLES

4X SCREW M10 L=40 DIN 933
 4X NUT M10 DIN 982
 4X WASHERS M10 DIN 125



L1 MOUNTING BOLTS KIT

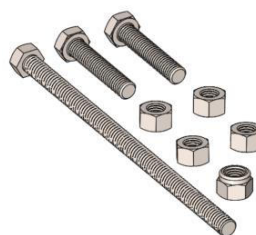
TIES - CENTRAL SADDLE

12X LONG SCREW M10
 12X NUT M10
 12X WASHERS M10

L2 MOUNTING BOLTS KIT

MOUNTING BOLTS KIT END PLATE - SPHERICAL BEARING (3 HOLES)

2X SCREW M8 L=40 mm
 2X NUT M8
 1X SCREW M8 L=140 mm
 2X NUT M8
 1X NUT M8 self locking



M MOUNTING BOLTS KIT

PILE HEAD - OMEGA PILE

2X THREADED ROD M16 L=160mm
 8X FLANGED NUT M16 DIN 6923



Q MOUNTING BOLTS KIT

MOUNTING BOLTS KIT MIDDLE PRESSFORMED PLATE - SPHERICAL BEARING (3 HOLES)

3X SCREW M8 L=40 mm
 3X NUT M8



QUANTITIES OF MECHANICAL COMPONENTS PER AXIS

TRACKER CONFIGURATION		TRJ 27
A1	RIGHT CENTRAL PRESSFORMED PLATE	1 per axis
A2	LEFT CENTRAL PRESSFORMED PLATE	1 per axis
B1	MIDDLE PRESSFORMED PLATE	8 per axis
B2	END STRAIGHT PLATE	0 per axis
AB	SPHERICAL BEARING	5 per axis
C	MIDDLE SADDLE	2 per axis
D	CENTRAL SADDLE	1 per axis
E	END SADDLE	2 per axis
F	LINEAR ACTUATOR	1 per axis
G	TIE	8 per axis
N'	MAIN BEAM	4 per axis
O'	CENTRAL OMEGA PILE	1 per axis
O''	LATERAL OMEGA PILE	4 per axis

* a control box drives up to 10x TRJ27-axes.

** For the correct positioning and use of the CENTRAL and LATERAL Omega Piles, check the chapter OMEGA PILES POSITIONING

EQUIPMENT

- For piles alignment: plumb line and a masonry chord or a laser pointer
- Cordless Screwdriver, metric socket set and a metal hook
- Cordless rivet applicator
- Metric spanner set
- Torque wrenchs from 2 Nm to 300 Nm
- Open insert for torque wrench 24 mm
- Digital Inclinometers (precision: 0,1°)
- Electricians tool kit
- Cable ties

- Tape measure

LIST REFERENCE PROJECT DOCUMENTS

In this manual, in order to help the explanation, the following project documents will be used as reference:

- PI1036PEPA00200-Tracker's Structure - Sections and views

OVERALL PROCEDURE

The overall sequence that have to be followed to mount the tracker is the following:

- Omega piles
- Pile heads and alignment procedure
- Saddles (central, middle and end)
- Main beams and ties
- Actuator assembly and setting at the tracking angle
- Actuator setting at = 0°
- Standard components for module support
- PV modules
- SKC control box

* for PV modules grounding please follow the manufacturer instructions

OMEGA PILES POSITIONING

Before starting to fix the central and lateral **O'** and **O''** omega piles, please refer to the image below to know where and how they will be used.



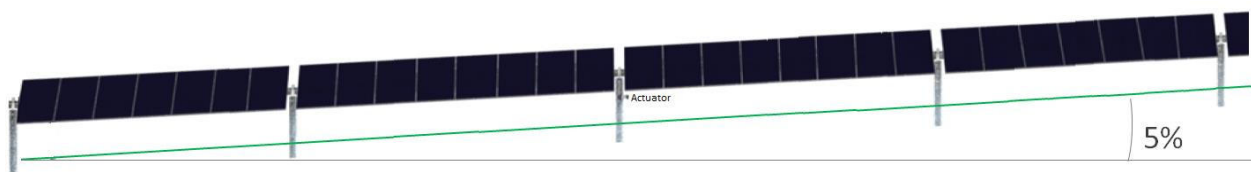
Central and Lateral Omega Piles **O'** and **O''**, after hammering, have the same measure out of the ground, so the next chapters, will be cited as Omega Pile **O** for both.

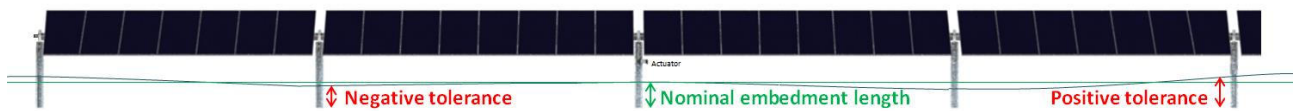
In the Nardò plant the trackers are divided into central and lateral. The tables below help to distinguish the piles and to reduce the errors of placing in an unsuitable position.



TYPES OF PROFILING PILES					
PILE POSITION	LENGTH	THICKNESS	DEPTH	MARKING	CONVERT
	mt	mm	Ω mm	IDENTIFICATION	CODE
Long Drive Post	2.67	3.5	155	XX	kt1275C2
Long Lateral Post	2.67	3.0	105	YY	kt1276C2
Drive Post	2.57	3.5	155		kt1281C2
Lateral Post	2.57	3.0	105		kt1278C2

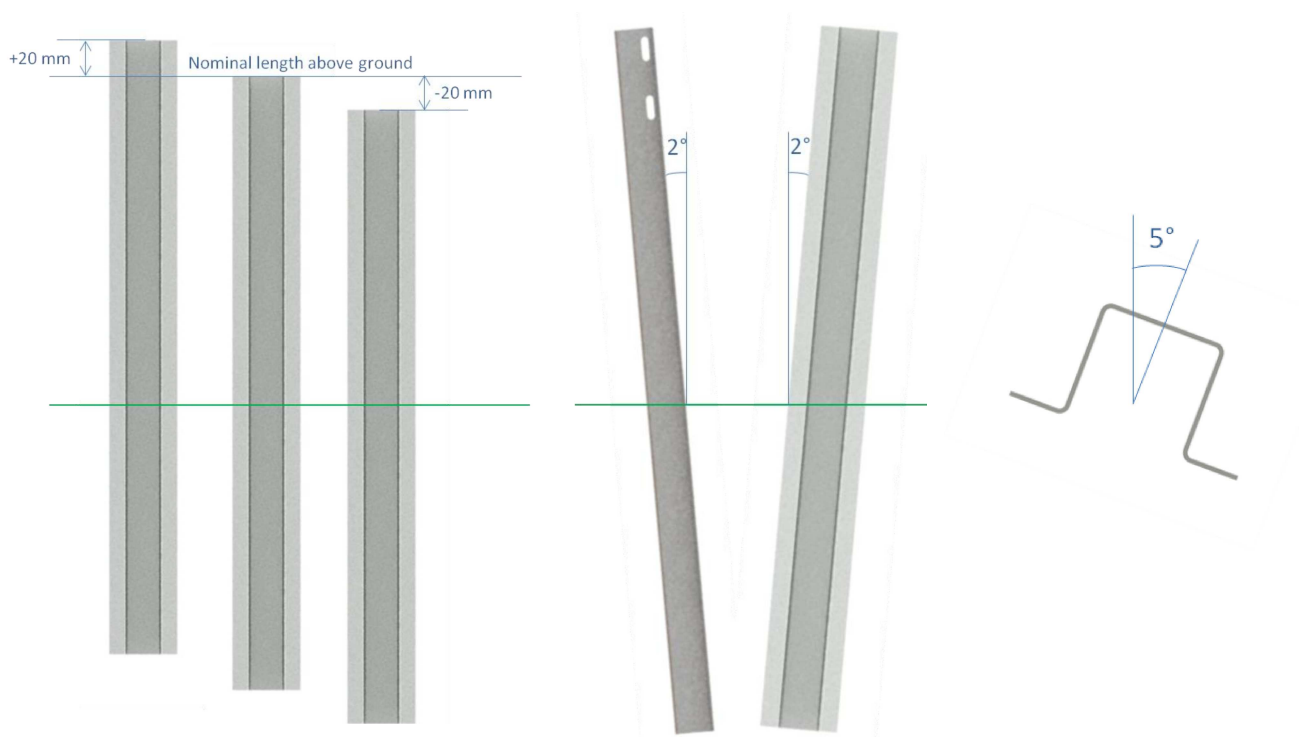
Then, follow the procedure below:


- The Tracker's N/S rotation axis should be parallel to the ground. Ground must have a maximum slope of $\pm 5\%$ respect the horizontal plane. The distance between the rotation axis and the ground can have a maximum local variation (tolerance on the embedment length), for compensating possible non-planarity of the ground. No limitations are imposed on the slope of the land in east-west direction as there are not mechanical connections between an axis and the next one.

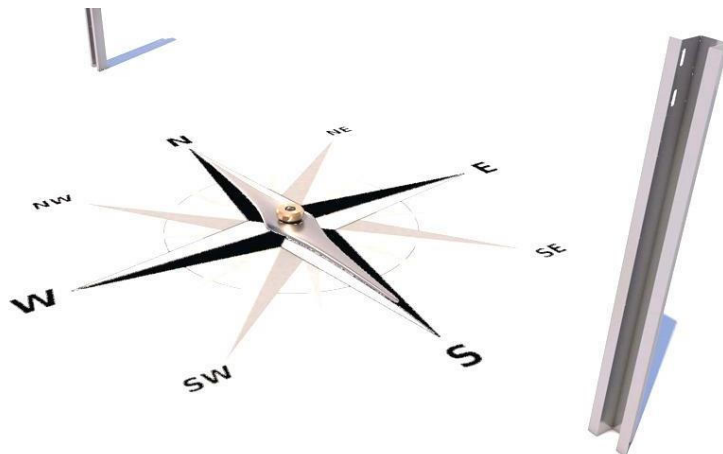




- Fix the omega piles  in consideration of the distances indicated in the "Tracker's Structure - Section and views". Use a GPS device to verify the correct positioning of the omega piles.
- Fix the omega piles  with a maximum error of:
 - ± 20 mm (height);
 - ± 2° tilt (respect to the vertical axis);
 - ± 5° twist.



- Fix the omega piles  making sure their concavity is pointed to WEST.



Make sure that, after driving the piles, zinc coating is still compliant to ISO 1461.
For further details, see Annex E – ZINC RENOVATION ON DAMAGED PILES

PILE HEAD ASSEMBLY

Before installing the pile heads on the omega pile, the pile heads must be assembled.

Then, proceed with the assembly using the component for the central pile head **A1 + AB + A2 =**

A, use the screws and nuts **Q** to complete the assembling. Observe the alignment between the two parts

A1 and **A2** before the complete tightening of the screws **Q**.



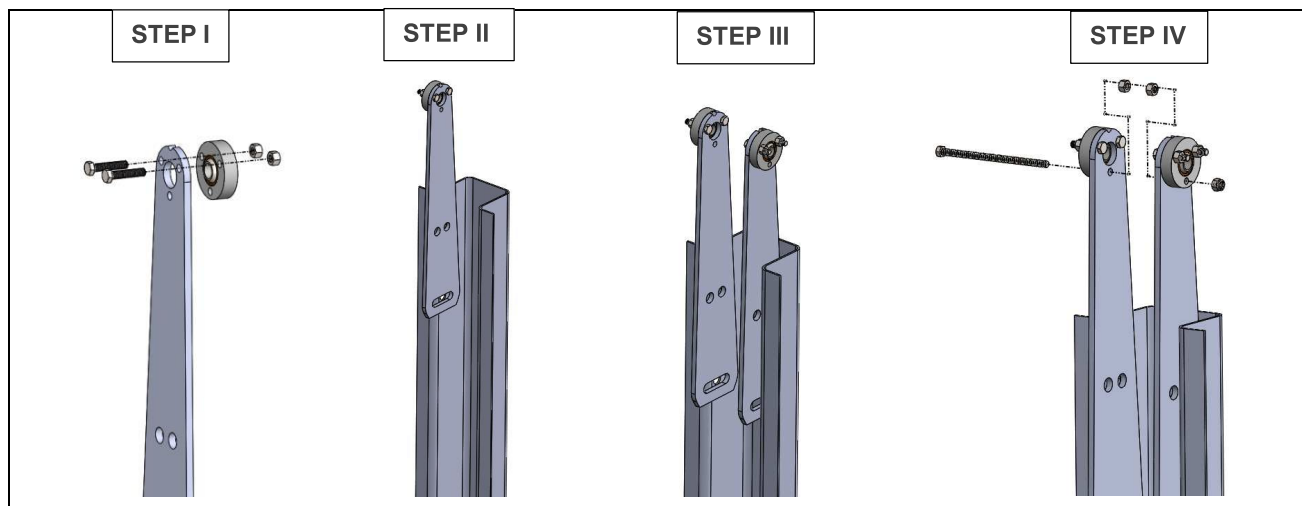
for the middle pile heads **B1+AB+B1 = B'**, use the screws and nuts **Q** to complete the assembling.

Observe the alignment between the two parts **B1** before the complete tightening of the screws **Q**.



and for the end pile heads (if it is present otherwise move to the next page) **B2 + AB + B2 =**

B'', use the screws and nuts **L2** to complete the assembling. (Please do not follow this step if the B2 component is not present)



Use the component **A1, A2, AB** on the **Q** (central pile head) on the central omega pile.

Use the component **B1, AB, B1** on the **Q** (middle pile head) on the middle omega pile.

Use the component **B2, AB, B2** and **L2** (end pile head) on the other omega piles.



BOLTS GROUP **Q**: 3x screw M8; 3x nut M8.

TIGHTENING TORQUE: 12 ± 10% Nm

BOLTS GROUP **L2**: 1x screw M8; 2x nut M8; 1x nut M8 self locking.

TIGHTENING TORQUE: 12 ± 10% Nm

CENTRAL, MIDDLE AND END PILE HEAD ASSEMBLY

Both for the central pile head **A** and for the middle and end pile heads **B'** and **B''** follow the instructions below. Insert the pile head on piles **O** driven to the ground, as shown in the scheme in the picture.



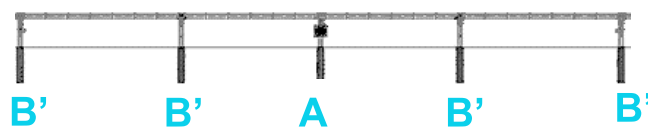
A



B'



B''



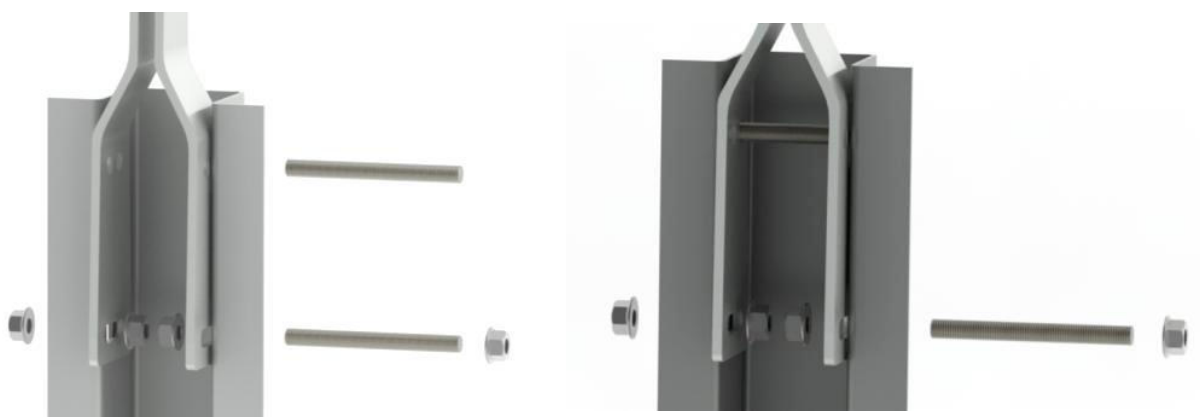
For TRJ27



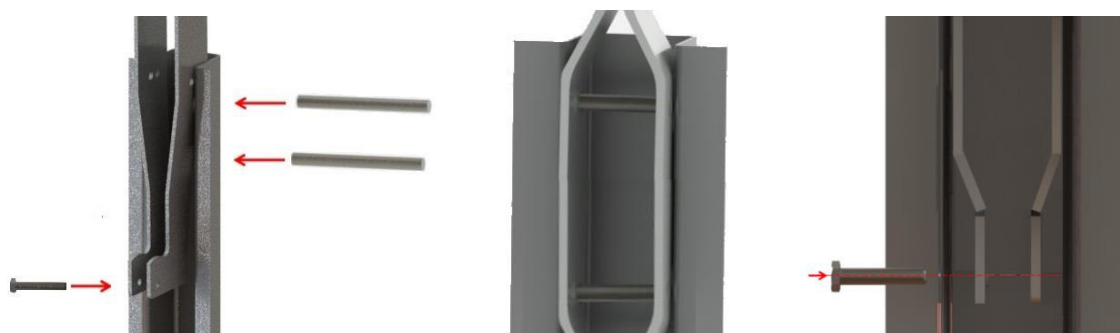
Use the component **A** (central pile head) on the 2 central omega piles (ACTUATOR). Use the component **B'** (middle pile head) and the component **B''** (end pile head) on the other omega piles.

Then, proceed with the assembly using the component **M** and **J**, as indicated in the picture below.

In the first stage, for middle **B'** and end **B''** pile heads, it is important to insert the threaded bar **M** with nuts (do not tighten the screw) in the LOWER oblong and the threaded bar **M** without nuts in any UPPER hole, to facilitate the following alignment of the pile heads.



for central **A**, it is important insert the threaded bar **M** in the any LOWER / UPPER holes and the screw **J** in the linear actuator hole position without nuts, to facilitate the following alignment of the pile heads.



Use the component **A** (central pile head) on the central omega pile. Use the component **B'** (middle pile head), **B''** (end pile head), **M** and **J** to help the alignment.

PILE HEAD ALIGNMENT

The omega pile can have an error in its position of 2° in all the directions (North, South, East, West), respect to the vertical.

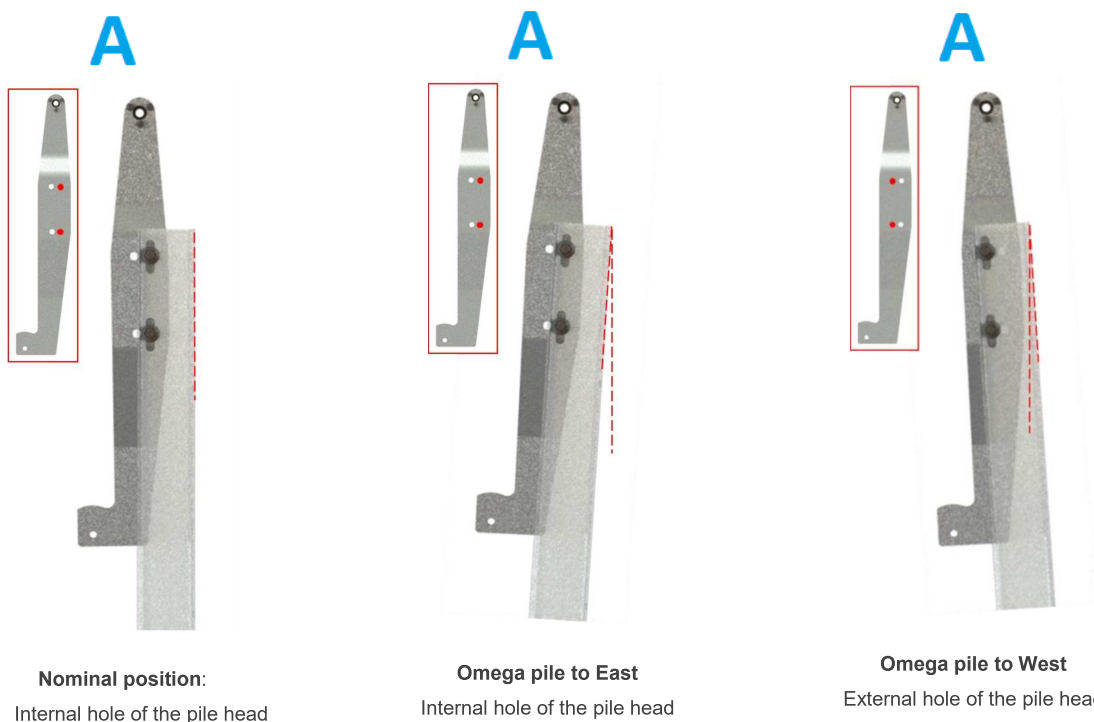
The error in the N/S direction is automatically compensated when mounting saddles and ties. The error in the E/W direction have to be compensated through the careful positioning of the pile head.

Depending on the way the omega pile is mounted, different positions are possible for the pile heads.

Begin the alignment by the adjustment of the central pile head **A**. For doing that, the first operation is verifying if the pile is inclined in the E/W direction. Three cases may occur:

- 1) The pile is mounted perfectly vertical in the E/W direction (nominal position): in this case use the two internal holes of the pile head, as indicated in the figure below:
- 2) The pile is mounted inclined in the East direction: in this case use the two internal holes of the pile head, as indicated in the figure below;
- 3) The pile is mounted inclined in the West direction: in this case use the two external holes of the pile head, as indicated in the figure below.

REGULATION OF CENTRAL PILE HEAD AND SHARED PILE HEAD



Then, put the central pile head to the centre of the buttonhole.

Once the position of the central pile head is defined, fix it by tightening the internal and external nuts of the threaded rods.

The other pile heads, **B**, must be positioned in such a way that the the rotation axis results to be aligned respect to the central pile head. To make it easier, start from the most external ones and then proceed with the internal ones.

In general, again, the position of the pile head is dependent on the pile inclination. When the omega pile is not inclined respect to the E/W direction, the pile head should be mounted using the internal hole, as shown in the first of the following pictures.

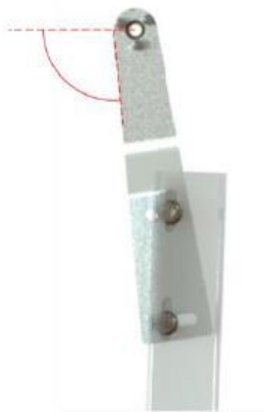
If the omega pile is pending in the E/W direction, to achieve a good regulation, it may be required to incline the head pile in the opposite direction respect to the omega pile inclination and also, if necessary, to move the top bar in the next hole.

The height of the spherical bearing in the top part of the pile head must be the same of central pile head, in order to achieve the alignment.

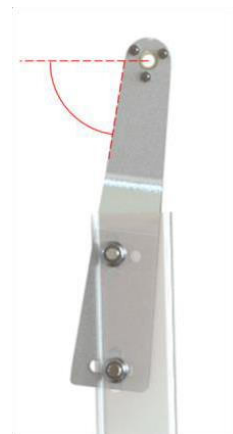
REGULATION OF MIDDLE PILE HEAD



Nominal position:
Internal hole of the pile head

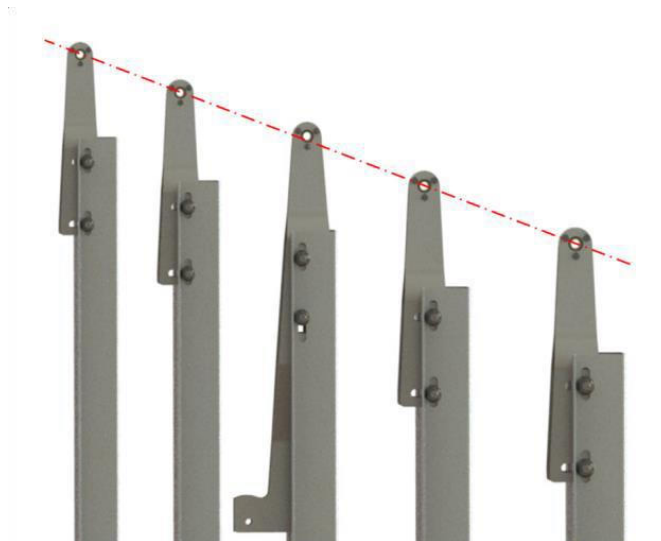


Omega pile to East
Internal hole of the pile head

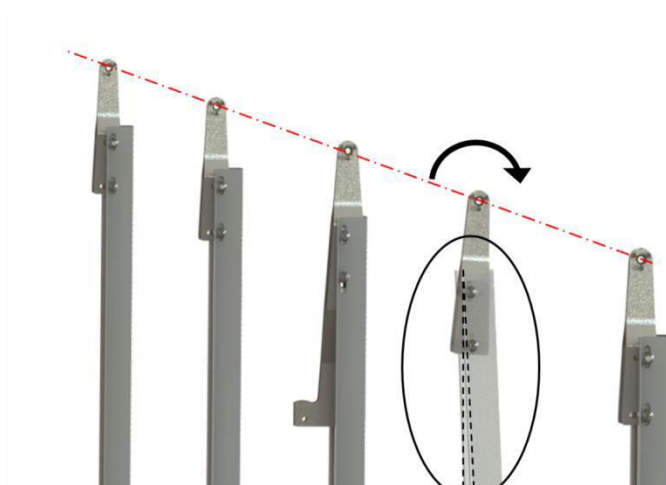


Omega pile to West
External hole of the pile head

Help with a laser pointer or stretch a cable (use the cut in the upper part of the pile head) from the first to the last pile head to ensure the proper alignment.



If necessary, remove the threaded bar and drop it on the next hole to allow the correct alignment as shown in the picture below.



If, after the procedure here explained, the alignment is still not good, it may be necessary to change the position of the central pile head, by moving it the vertical hole of the omega pile.

After the alignment of the pile head it is possible to fix it:

- tighten the nuts of lower bar
- remove the upper bar, place nuts and tighten it.



BOLTS GROUP M: 2x threaded rod M16; 8x flanged nut M16



TIGHTENING TORQUE: $200 \pm 10\%$ Nm (it refer to all nuts, internal and external).

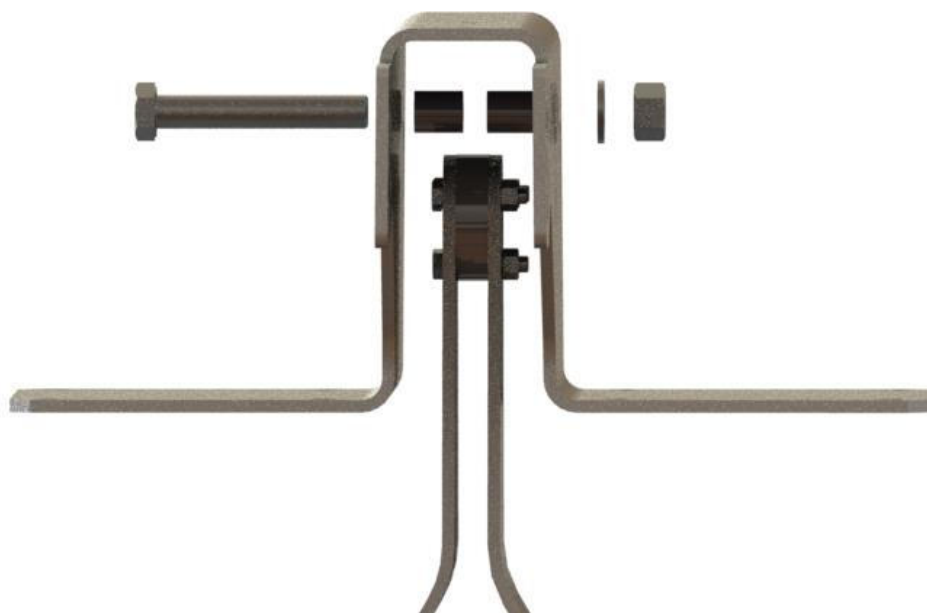
After the tightnening of the all pile head nuts, further tighten the internal nuts of the central pile head up to $270 \pm 10\%$ Nm.



Use the component **A** (central pile head) on the central omega pile. Use the component **B** (middle and end pile head) on the other omega piles.

CENTRAL SADDLE ASSEMBLY

Fix the central saddle **D** on the central pile head **A** using the bolt group **H**, as shown in the following pictures.



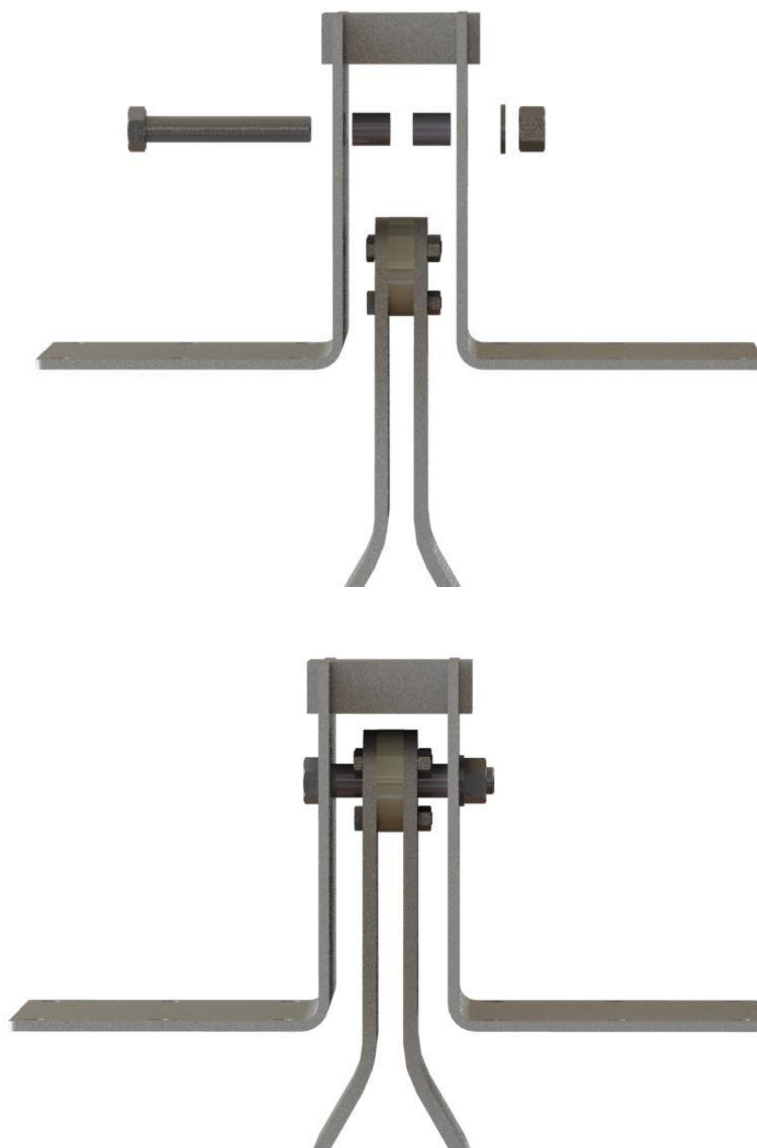
BOLTS GROUP **H**: 1x screw M16; 1x nut M16; 1x washer M16; 2x spacers for M16



TIGHTENING TORQUE: $90 \pm 10\%$ Nm. After the tightening check if the spacers are not free to move. If they are loose, the tightening torque should be increased until they are not free to move. In any case the tightening torque cannot exceed 280 Nm.

MIDDLE SADDLE ASSEMBLY

Fix the middle saddle **C** on the middle pile heads **B'** using the bolt group **H**, as shown in the following pictures.



BOLTS GROUP **H:** 1x screw M16; 1x nut M16; 1x washer M16; 2x spacers for M16

TIGHTENING TORQUE: $90 \pm 10\%$ Nm. After the tightening check if the spacers are not free to move. If they are loose, the tightening torque should be increased until they are not free to move. In any case the tightening torque cannot exceed 280 Nm.



END SADDLE ASSEMBLY

Fix the 2 end saddles **E** on the end pile heads **B''** using the bolt group **H**, as shown in the following pictures.



BOLTS GROUP **H**: 1x screw M16; 1x nut M16; 1x washer M16; 2x spacers for M16

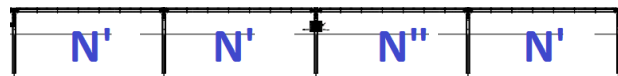
TIGHTENING TORQUE: $90 \pm 10\%$ Nm



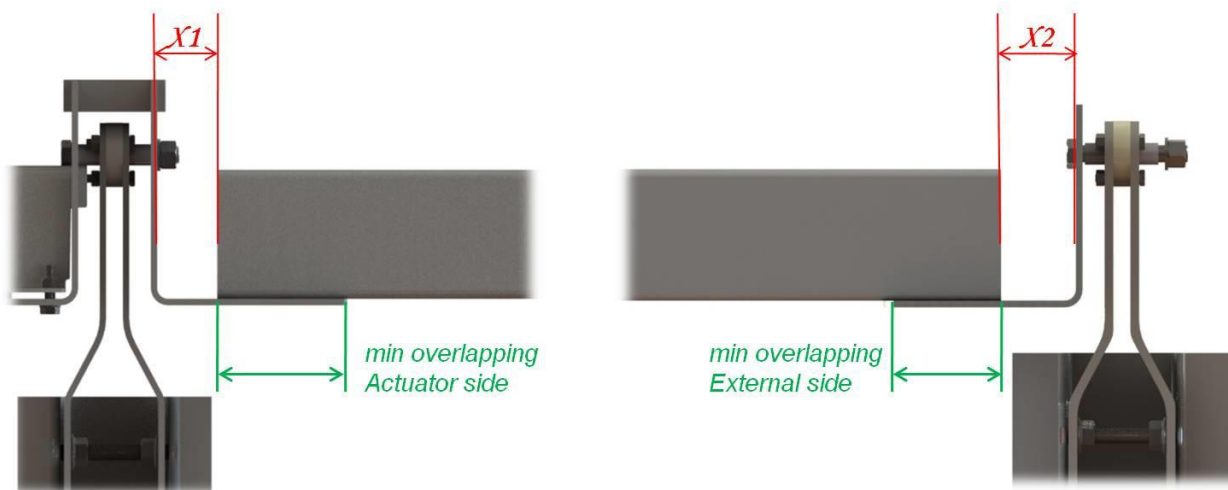
Be careful to place the screw with the head on the side of the saddle, as shown in the figures above.

MAIN BEAM AND TIE ASSEMBLY

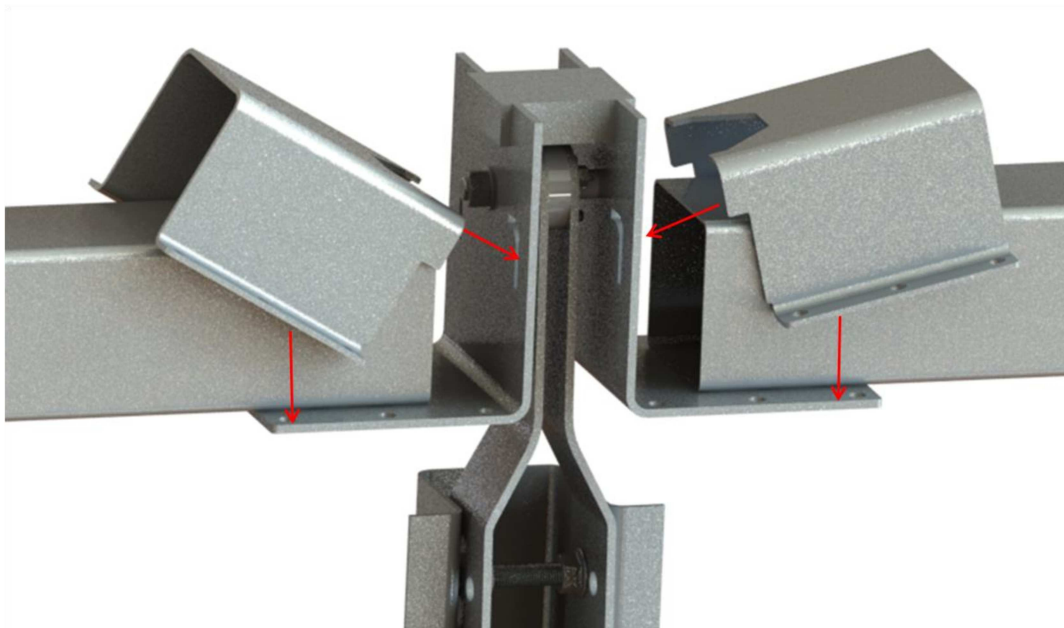
- Place the main beam **N'** and **N''** between two saddles, in the sequence shown in the drawing below, taking care that there is a minimum overlapping between the main beam and the saddle on the Actuator Side of 90 mm, and a minimum overlapping between the main beam and the saddle on the External Side of 50 mm.



For TRJ27



- Place the mechanical ties **G** on the main beam; they have to be placed in such a way that the protruding parts enter the slots of the saddles.

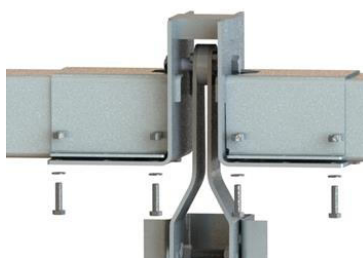


- Fix the ties to the saddles by means of the bolts of the groups **K**, in the case they are fixed on middle saddles **C** or end saddles **E**, and with the bolts of the group **L**, in the case they are fixed on the central saddle **D**, as shown in the figure below

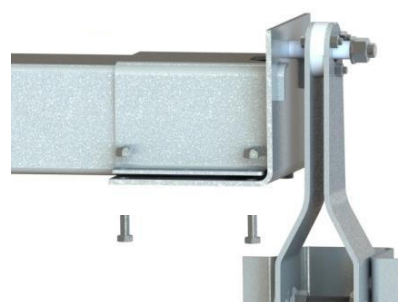
Central saddle - Bolt group **L1**



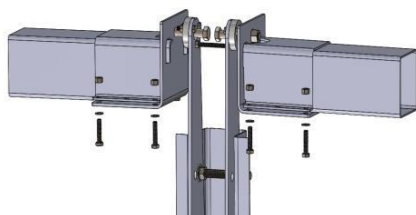
Middle saddle - Bolt group **K**

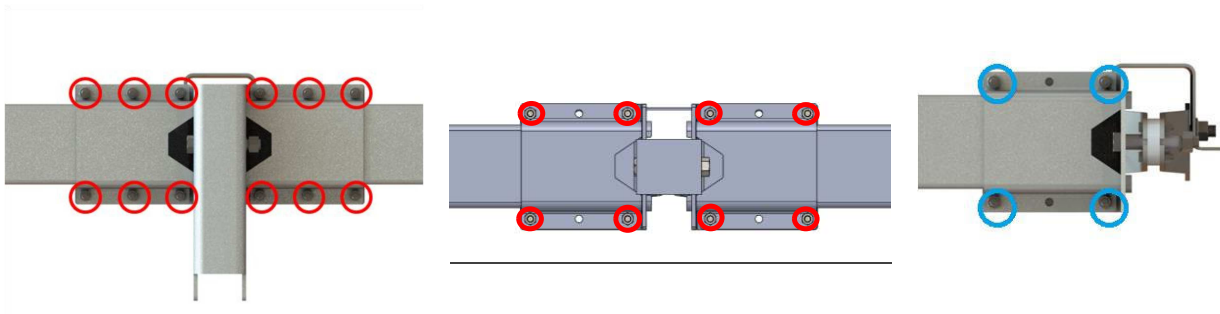


End saddle - Bolt group **K**

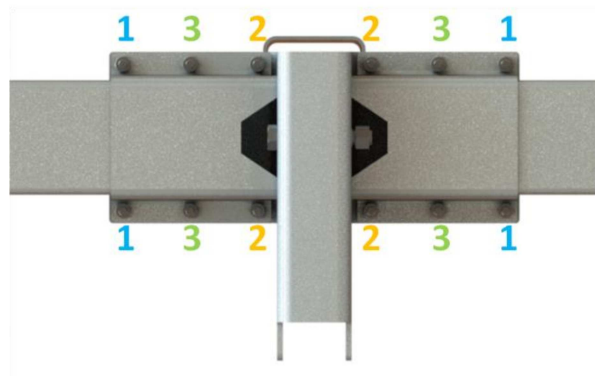
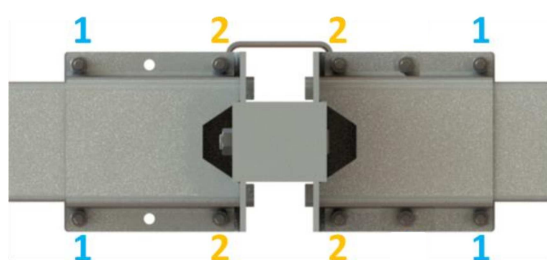


End saddle - Bolt group **K**

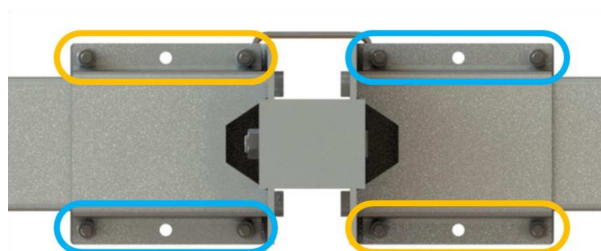




- For each tie, screws should be tightened in the order shown in the figure below, taking care to tighten together the screws indicated by the same number (1, 2, 3) alternating the tightening among them until reaching the suggested value.



- After tightening, place 2 inclinometers on the two main beams at the sides of the saddles, taking care that difference between the measures indicated by the two inclinometers is less than 1° . For reaching that value is suggested to regulate the tightening of the couples of bolts indicated with the same color in the figure below.



BOLTS GROUP K: 4x screw M10 L=40mm ; 4x nut M10; 4x washer M10



BOLTS GROUP L: 12x screw M10 L=40mm ; 12x nut M10; 12x washer M10

TIGHTENING TORQUE: 20-45 Nm.

The tightening can stop when n.1 thread comes out of the nut. The wings of the tie can deform.



The minimum overlap indicated between the main beam and the saddle must be respected.
NEVER let this quantity to be less.

LINEAR ACTUATOR ASSEMBLY

Before assembling the actuator it is necessary to position the metallic tie **C1** on it. First the metallic tie should be enlarged, by hand, till the point it fits on the actuator like in the picture below:



Once the metallic tie is positioned, slide it till the lower end of actuator like in the following picture, and then it should be tightened on the actuator, always by hand.



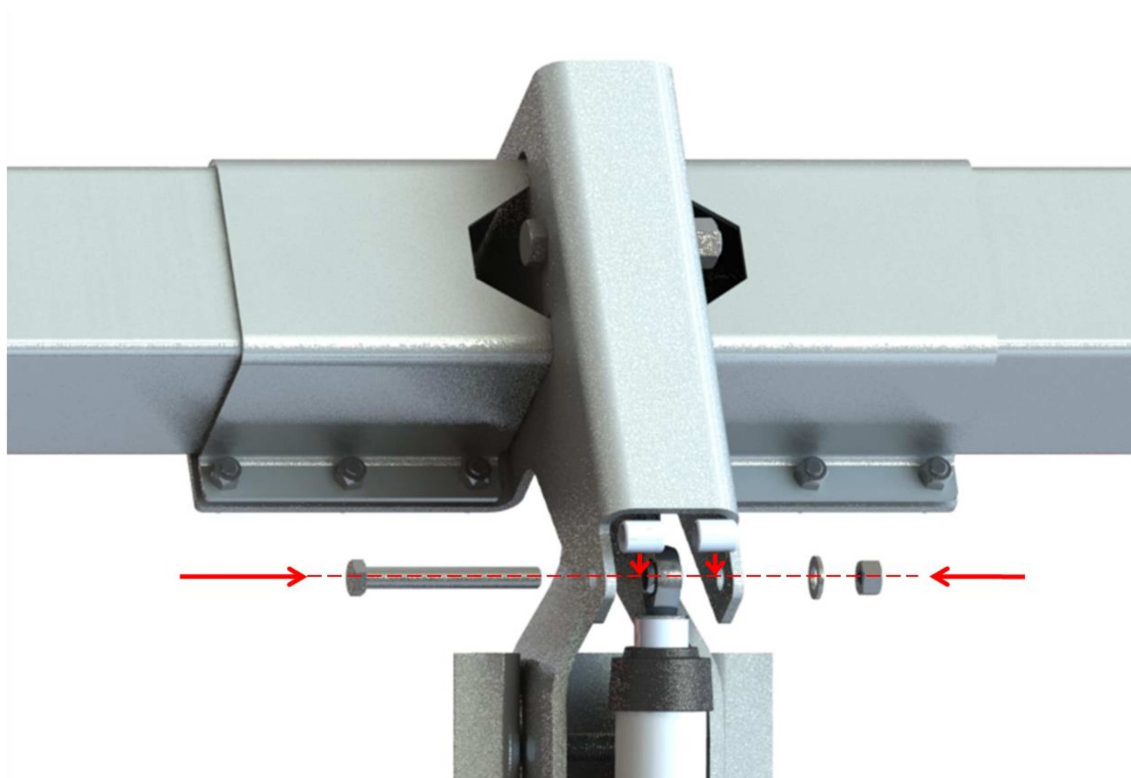
The cut on the
metallic clamp
faces the motor

Now it is possible to assemble the actuator on the tracker.

For having a good tracking it is of primary importance that the position of the central saddle is correct. This means that the linear actuator assembly requires particular attention.

The actuator is provided in the closed position (IN), with a distance between the upper and lower joint of 630 mm, that is the nominal one. This distance can be regulated by screwing or unscrewing the lower joint, in a range of 621-638 mm.

Fix the upper part of the actuator with the bolts group **I**. Until the end of the assembly and the later regulation at 0° (page 43), it is not necessary use washer, spacers and nut.



BOLTS GROUP I: 1x long screw M14; 2x long spacers for M14

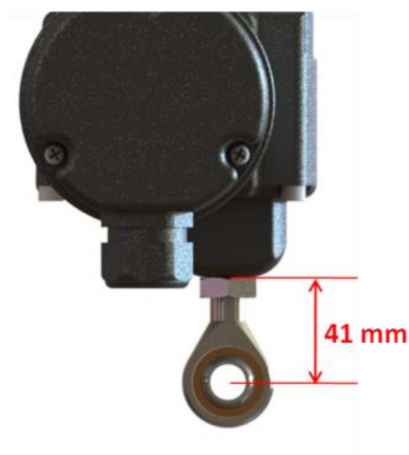
Place a digital inclinometer on the top part of the central saddle, in order to monitor the angle reached during the regulation. The digital inclinometer must have a precision of $0,1^{\circ}$.



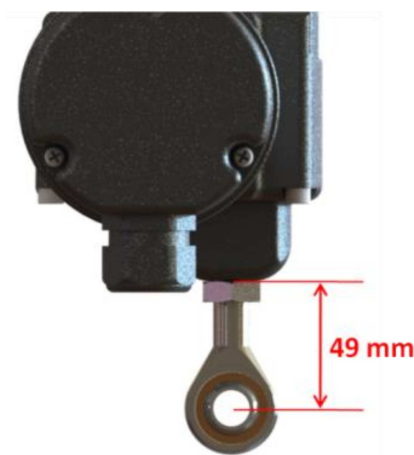
Turn the lower joint of the actuator up to obtain an angle of $55,0^{\circ}$ - $55,6^{\circ}$ of the saddle. After the regulation is completed, remember to use the bolts group **J** of the lower joint.



Joint all IN
(n.1 visible thread)

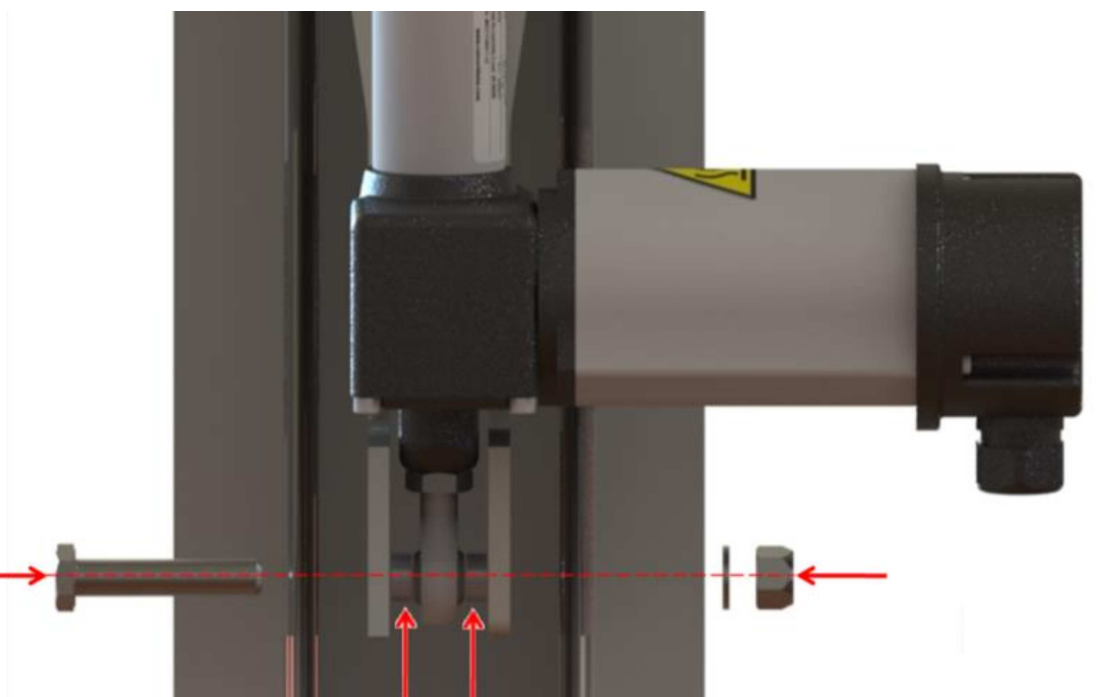


Joint NOMINAL position
(n.7 visible threads)



Joint all OUT
(n.13 visible threads)

Once you have made the adjustment, permanently fix the lower part of the linear actuator **F** on the central pile head **A** using the bolts group **J**.



BOLTS GROUP **J**: 1x short screw M14; 1x nut M14; 1x washer M14; 2x short spacers for M14

TIGHTENING TORQUE: $30 \pm 10\%$ Nm



Never unscrew the lower joint leaving more than 14 threads out.
The actuator angle varies by $0,2^\circ$ every 0,5 round, producing a precision in the regulation of 0.75 mm.



Be careful that, during the actuator assembly, the push rod is in the factory position, indicated by a red line. Once the actuator is mounted, the red line should be in the visible half of the actuator, as shown in the figure below. In case of accidental movement, it is necessary to restore the initial position of the actuator before proceeding to the final assembly.



RED LINE



OK




NO



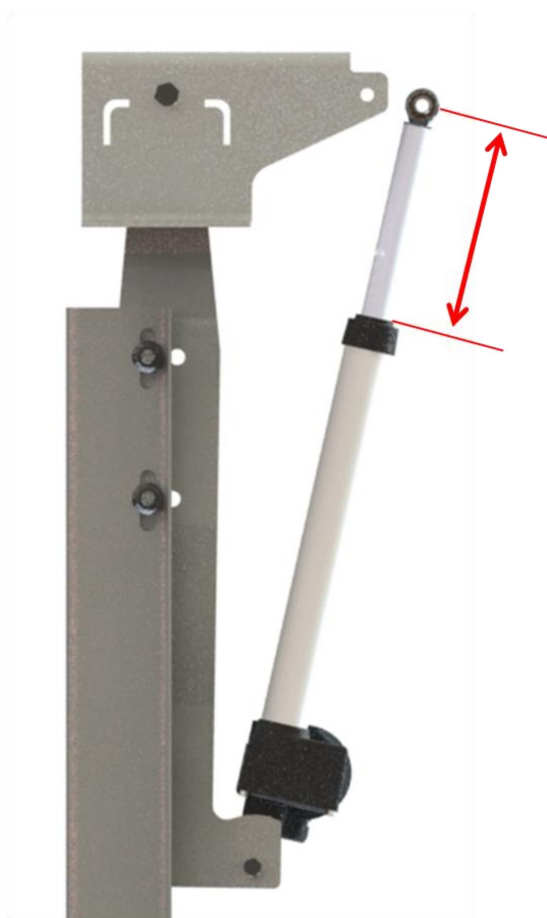
If the regulation are not sufficient for obtaining an inclination of the saddle of $55,0^{\circ}$ - $55,6^{\circ}$, this means the omega pile has an error greater than $\pm 2^{\circ}$, or the pile head have not been aligned in the correct way, respecting the maximum and minimum angles.

LINEAR ACTUATOR AT = 0°

Remove the screw  from the upper joint of the actuator and extract it from the saddle.

Insert in the joint the hook, which have to be previously connected to a cordless screwdriver at slow speed.

Turn the upper joint in the counterclockwise direction, until the pull rod is out and the saddle is perfectly horizontal.



fix the upper part of the actuator using the same hole previously chosen, using the bolt group .

BOLTS GROUP : 1x long screw M14; 1x nut M14; 1x washer M14; 2x long spacers for M14



TIGHTENING TORQUE: 100 ± 10% Nm. After the tightening check if the spacers are not free to move. If they are loose, the tightening torque should be increased until they are not free to move. In any case the tightening torque cannot exceed 150 Nm.



To avoid the actuator overheating, it is mandatory regulate the velocity of the cordless screwdriver in order to not take less than 20 seconds to reach the 185 mm out of the pull rod.

5. SKC CONTROL BOX WIRING

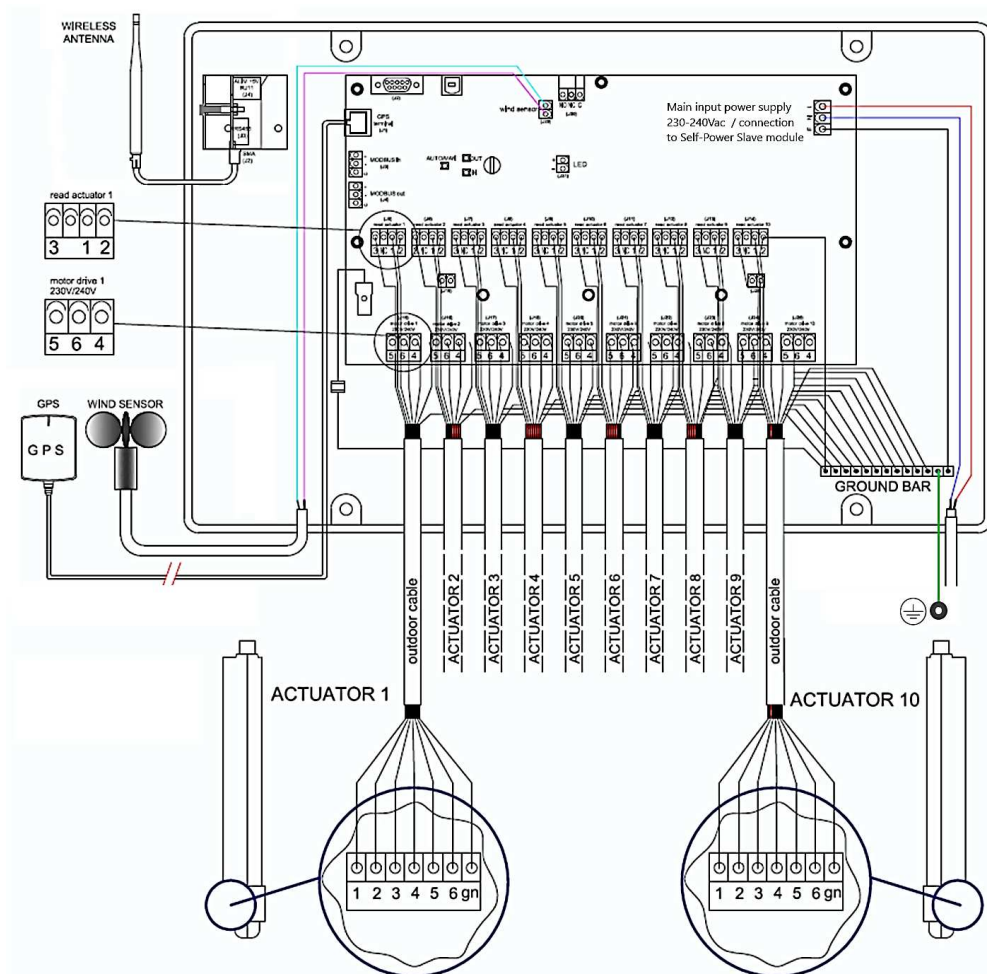
Wire the linear actuators and the power supply to the SKC, as indicated in the figure below.

When included, also the additional components must be wired: wind sensor and GPS, wireless antenna or RS485 communication protocol cable.

Please pay attention to connect ground bar to protective earth (PE) with a conductor cross-section according to the electric system characteristics.

In order to size the circuit breakers please consider also lenght and cross-section of the actuator cable.

To avoid unwanted trippings please use a circuit breaker with a residual current threshold ≥ 300 mA.



The maximum length of the actuator cables should be 65 m.

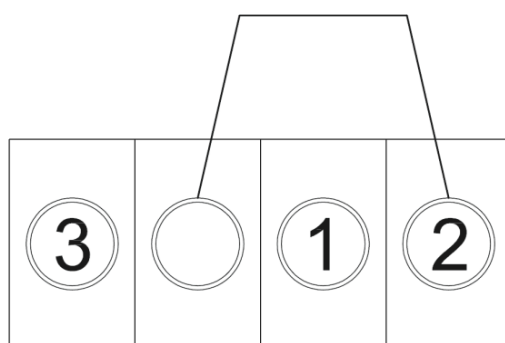
The maximum length of the overall actuator cables connected to the same SKC must be less to 400 m.

The mean distance between actuator cables and the pv solar cells and pv cables should be more then 120 mm.

ACTUATOR WIRING

As shown in the diagram at page 35, the actuator will be connected to the SKC through a shielded multipolar cable $4 \times [1,5 \text{ mm}^2 \text{ or } 2,5 \text{ mm}^2] + 3 \times [0,5 \text{ mm}^2 \text{ or } 0,75 \text{ mm}^2 \text{ or } 1,5 \text{ mm}^2]$, unless otherwise specified in local regulations. It is very important to connect each pole to the connectors of SKC according to the numbering shown in the table. Each cable must be connected to the ground bar inside the SKC box.

If you connect less than 10 actuators on the SKC, the empty clamps must be wired as follows:



Any wrong connection of the poles could cause electrical and mechanical damages.

SKC POWER CABLE

The SKC control box must be powered according to the parameters indicated on page 8.

Usually a cable 3 x 1,5 mm² is widely sufficient to ensure the power supply of the control box up to 90 m of distance from the switchboard of the power supply. The termination block mounted on the control box is of such size as to allow the use of a 3 x 2,5 mm².

The wiring of the power cable to the box must take place as indicated on the table on page 35. It is important that the earth of the power cable is connected to the ground bar as indicated in the diagram.



Never touch the power cable of the SKC after connecting the Strings circuit on the Photovoltaic Modules.

6. TEST PROCEDURES

INSTRUMENTATION , EQUIPMENT AND NECESSARY DOCUMENTATION

- Test Report
- Digital Inclinometer
- Multimeter
- Torque Wrench
- Tape Measure

INSPECTION AND EQUIPMENT PRELIMINARY CHECKS

- Check for 230 V~ voltage.
- Check for the presence of all mechanical components.

MECHANICAL TEST PROCEDURE

- Verify the correct tightening of the pile heads to the respective omega pile.
- Verify the correct tightening of the saddles to the respective pile head.
- Verify the correct tightening of the main beam to the saddles placed on the respective ties. Ties must be strongly tightened.
- Verify the correct tightening of the modules support.
- Verify the correct tightening of the screws and nuts on the top and bottom of the actuator.

ELECTRICAL TESTING PROCEDURE

- Verify the correct wiring of the actuator to the SKC control box.

TRACKER MOTION TEST PROCEDURE

- The startup and the tracker functional test must be agreed with personnel of Convert Italia SpA.

7. ANNEX INDEX

A - MODULE SUPPORTS ASSEMBLY

B - SKC MECHANICAL ASSEMBLY

C - ANEMOMETER, GPS MECCANICAL ASSEMBLY

D - WIRELESS SYSTEM ASSEMBLY

E – ZINC RENOVATION ON DAMAGED PILES

ANNEX A

A - MODULE SUPPORTS ASSEMBLY

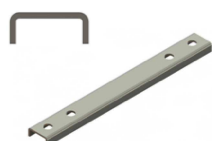
STANDARD COMPONENTS FOR MODULE SUPPORT STRUCTURE



P MODULE SUPPORT - TYPE A



R MODULE SUPPORT - TYPE C



T LONG PLATE

BOLTS AND NUTS FOR STANDARD COMPONENTS



V MOUNTING BOLTS STANDARD

MODULE SUPPORTS - TYPE A

-

LONG PLATE

2X LONG SCREW M8

2X SELF-LOCKING NUT M8

2X WASHERS M8

QUANTITIES OF MECHANICAL COMPONENTS PER AXIS

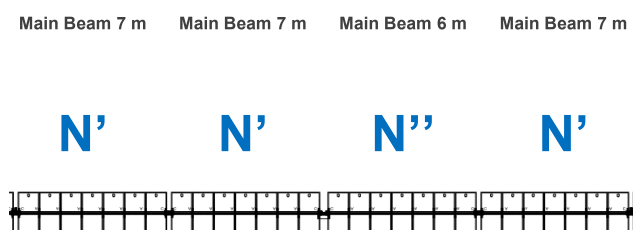
TRACKER CONFIGURATION		TRJ 27
P	MODULE SUPPORT – TYPE A	23 per axis
R	MODULE SUPPORT – TYPE C	8 per axis
T	LONG PLATE	31 per axis

TRACKER STRUCTURE

The tracker structure is composed by:

- Main beams **N'** (7 PV Modules) with 7X module support type A **P** and 2x module support type C **R**,
- Main beams **N''** (6 PV Modules) with 8X module support type A **P** and 2x module support type C **R**,

The figure below shows examples of tracker structure, with the positioning of each type of main beam and the number of PV module for it case.

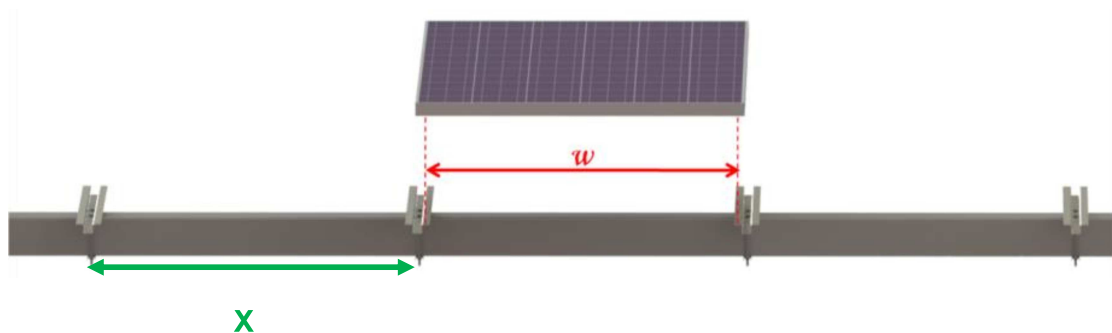


For TRJ 27

MODULE SUPPORTS ASSEMBLY

The PV modules are fixed to the tracker through the module supports. For the module supports disposition refere to the project document *“Tracker’s Structure - Section and views”*.

For mounting the module supports always consider that the distance ***w*** between the closest holes of two adjacent module supports must be equal to the interaxis of mounting holes of the PV module.



Progressive distance for mounting module support Type A and Type C on the main beam shall be around **X = 1062 mm**

The mounting procedure for both Main Beans 7m **N'** is explained below.

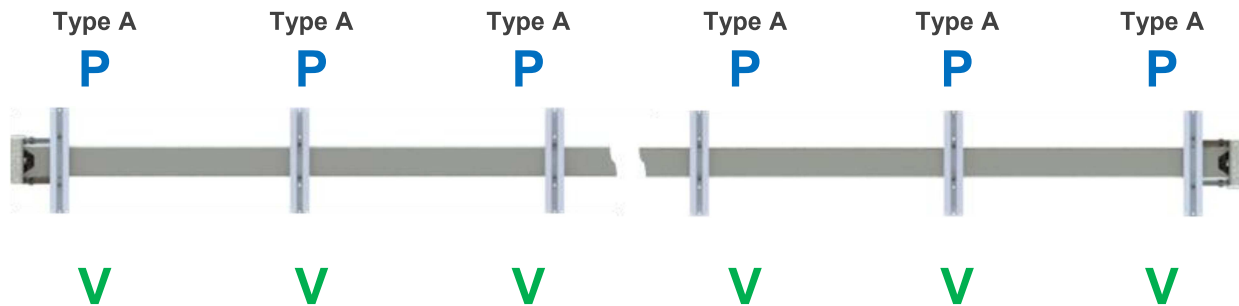
Once the module supports have been mounted, PV modules can be fixed on them, by following the specific indication provided by dedicated project documents.

Furthermore it should be followed instruction supply by the PV module manufacturer, as for example the grounding.

For mounting, consider the module support disposition shown in the figures below.

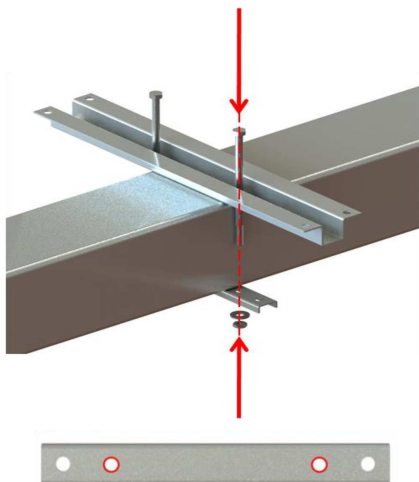
MODULE SUPPORTS DISPOSITION

When in the Main Beams **N'** and **N''**:

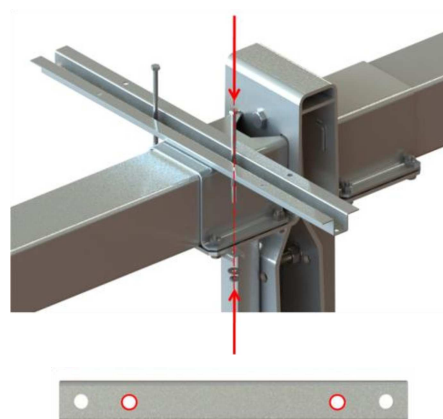


The module supports are fixed by means of the long plates **T**, as follows:

When the support modules **P** are used for positioning on the main beam **N'** and **N''**, fix them using the internal holes on the long plate.



Module support type A **P**



Module support type C **R**

- The tightening of each of the screws on each side of the long plate should be equalized, as well as the number of threads, avoiding the unbalance of the support.
- After tightening, check the number of threads remaining on each of the screws on the same long plate is similar.

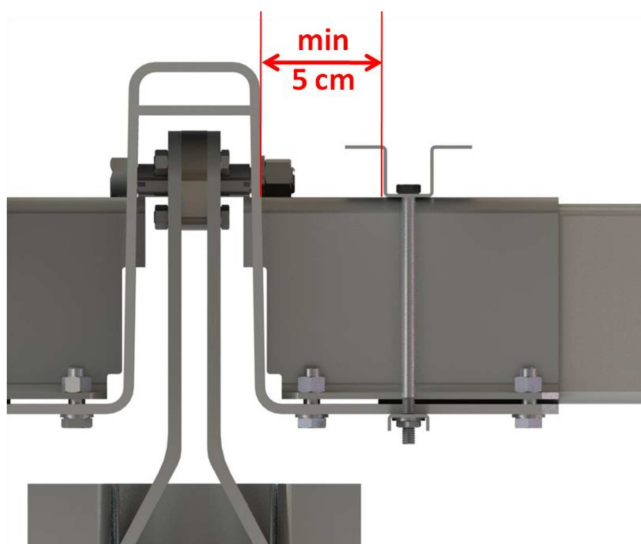


BOLTS GROUP V : 2x long screw M8; 2x washer M8 ; 2x self-locking nuts M8

TIGHTENING TORQUE: reference value $6 \pm 30\%$ Nm; whenever the friction acted by the self-locking nut is too high and the proposed torque is not enough, it is possible to increase it over the maximum limit suggested above, until achieving the components packed, always avoiding the deformation of components.



It is suggested to leave at least 5 cm between the vertical side of the ending module support and the saddle.



Once the tracker structure is fully mounted, the PV modules can be fixed on the module supports, according to the Annex A1- PV panels installation with anti-unscrewing screws.

ANNEX B

B - SKC MECHANICAL ASSEMBLY

SKC BOX SUPPORT COMPONENTS



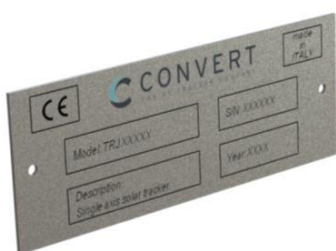
SKC SUPPORT PLATE

1 per SKC control box



SKC CONTROL BOX

1 each 5x TRJ58-axes



TRACKER NUMBER PLATE

1 per SKC control box



MOUNTING BOLTS

SKC CONTROL BOX – SKC SUPPORT PLATE

4X CROSS HEAD SCREW M5
4X FLANGED NUT M5



MOUNTING BOLTS

SKC SUPPORT PLATE – FOUNDATION PILE

2X SHORT SCREW M10
2X NUT M10
2X WASHER M10

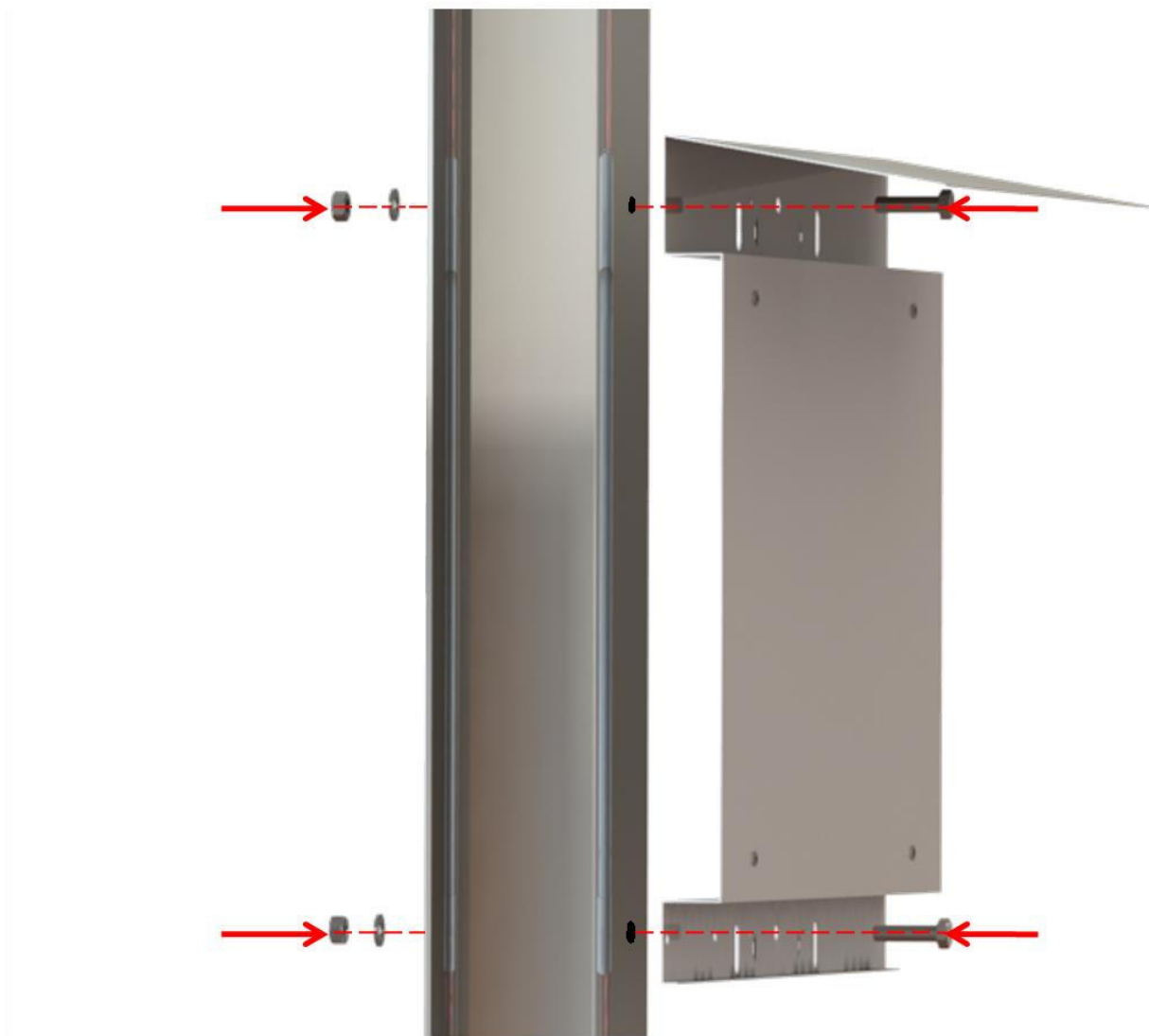


MOUNTING RIVETS

TRACKER NUMBER PLATE – SKC SUPPORT PLATE

2X RIVETS 4mm

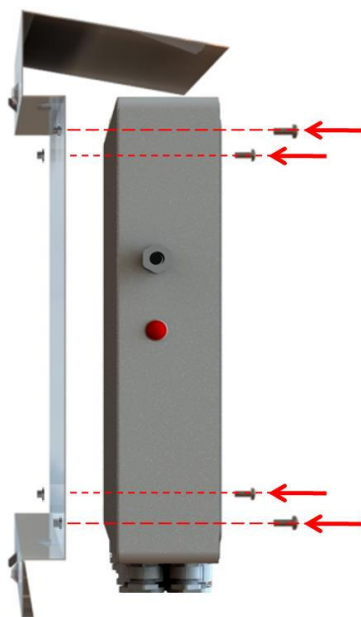
With the screws M10, fix the support plate to the foundation pile, using the two holes on the pile.



BOLTS: 2x screw M10; 2x washer M10 ; 2x nuts M10

TIGHTENING TORQUE: $15 \pm 30\%$ Nm

Once the support plate is fixed, position on it the SKC control box and fix it using the M5 cross head screws, as indicated in the picture below.



BOLTS: 4x cross-head screw M5

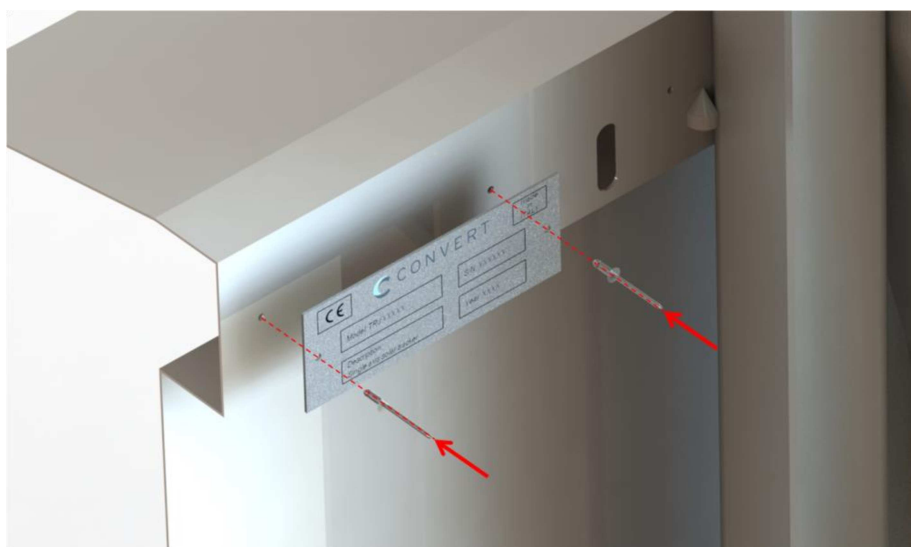
For cabling, choose the right PG following the instructions::

- PG16 (blue in the figure) use them for actuators;
- PG13,5 (Pink color) use them for GPS and anemometer;
- PG13.5 (yellow in the figure): use them for feeding and earth grounding;
- PG11 (orange arrow in the figure): use it for the wireless antenna.



- PG16
- PG13.5
- PG11

The tracker number plate has to be fixed on the rear side of the SKC support plate, as indicated in the following figure, by means of 2 rivets 4mm.



BOLTS: 2x rivets 4mm

ANNEX C

C - ANEMOMETER, GPS MECCANICAL ASSEMBLY

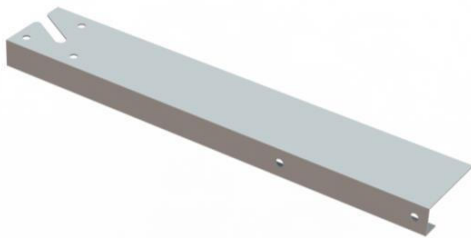
(Follow ANNEX C if SCADA is not installed)

COMPONENTS FOR ANEMOMETER GPS and SELF-POWER ASSEMBLY



WIND SENSOR (ANEMOMETER)

1 per SKC control box



WIND SENSOR SUPPORT (ANEMOMETER)

1 per SKC control box



MOUNTING BOLTS

WIND SENSOR SUPPORT – SKC SUPPORT PLATE

and WIND SENSOR – WIND SENSOR SUPPORT

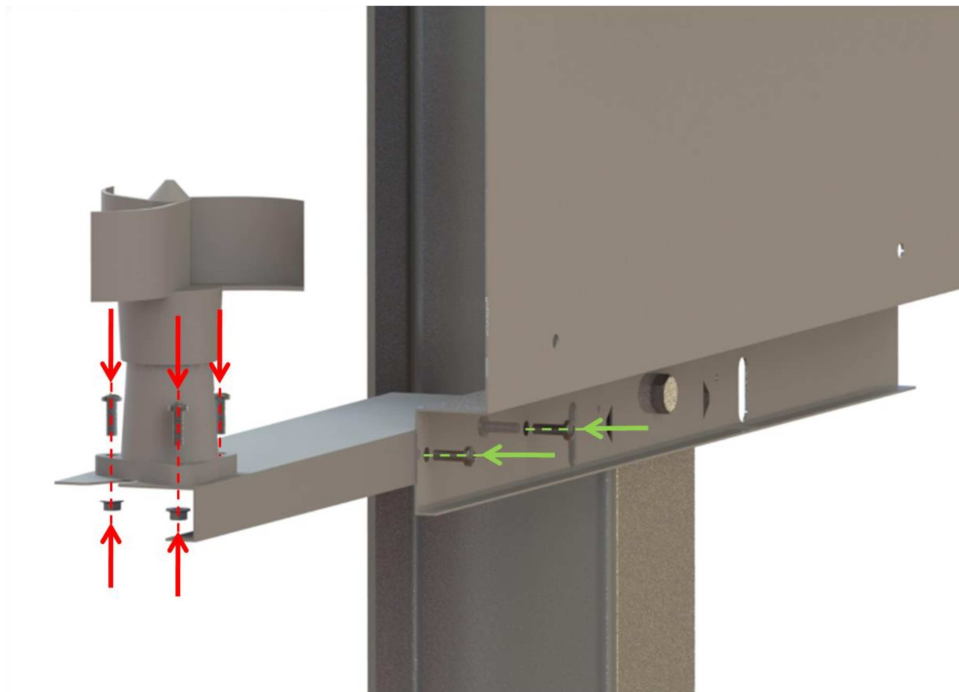
5X CROSS HEAD SCREW M5 L=16mm
5X FLANGED NUTS M5



GPS

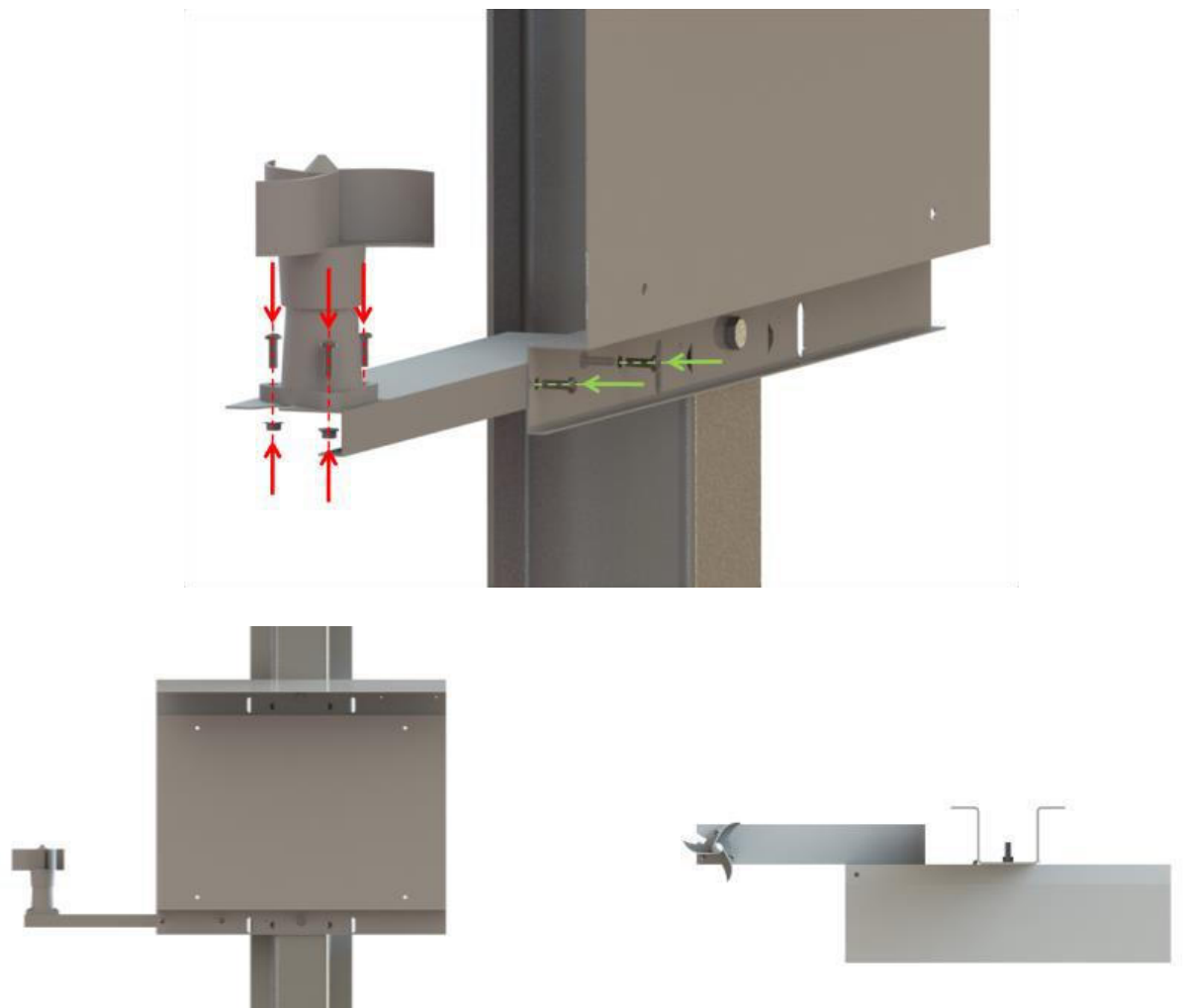
1 per SKC control box

Fix the anemometer support on the SKC support plate by means of n.2 screws and nuts M5. Then, use the remaining screws and nuts to fix the actuator to its support.



BOLTS: 5x cross-head screw M5 and 5x flanged nut M5

Position the Self-Power Slave box on the back of the SKC Control support plate and fix it using the M5 cross head screws, as indicated in the picture below.



BOLTS: 5x cross-head screw M5 L=16mm; 5x flanged nuts M5
TIGHTENING TORQUE: 2-3 Nm

The GPS has a magnet on its rear side, that allows to fix it directly on the omega pile.



ANNEX D

D - WIRELESS SYSTEM ASSEMBLY

COMPONENTS FOR WIRELESS SYSTEM ASSEMBLY



ANTENNA

1 per SKC control box
1 per sub-field



WIRELESS MASTER SUPPORT PLATE

1 per sub-field



WIRELESS MASTER BOX *

1 per sub-field

* The minimum distance between 2 Master Wireless Boxes must be more than 6m



MOUNTING BOLTS

WIRELESS MASTER BOX – WIRELESS MASTER SUPPORT PLATE

2X CROSS HEAD SCREW M5
2X FLANGED NUT M5



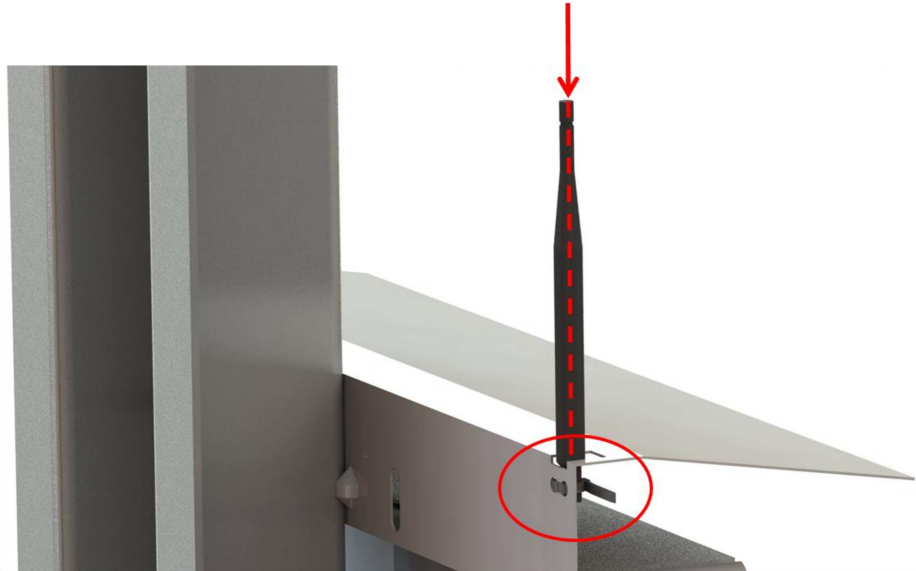
CABLE TIES

ANTENNA – MASTER/SKC SUPPORT PLATE

2X CABLE TIES 4,8X120 per SKC
2X CABLE TIES 4,8X120 per MASTER

ANTENNA AND SKC ASSEMBLY

The wireless antenna has to be inserted into the hole sited on the top roof of the SKC support plate and fixed by means of a plastic cable tie 4,8X120mm or similar, that should pass through the two holes below.

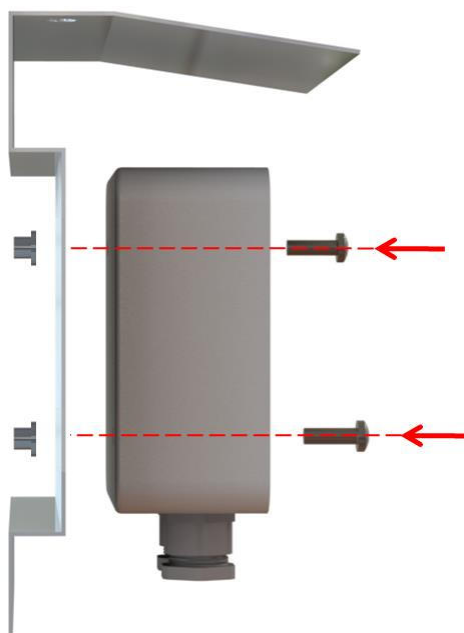


After that, make sure that the wire of the antenna fall almost vertical and fix it to the lateral hole on the SKC support plate by means of the other plastic cable tie 4,8X120mm or similar, as indicated in the figure below.



WIRELESS MASTER ASSEMBLY

Position the master box on the master support plate and fix it using the M5 cross head screws, as indicated in the picture below.

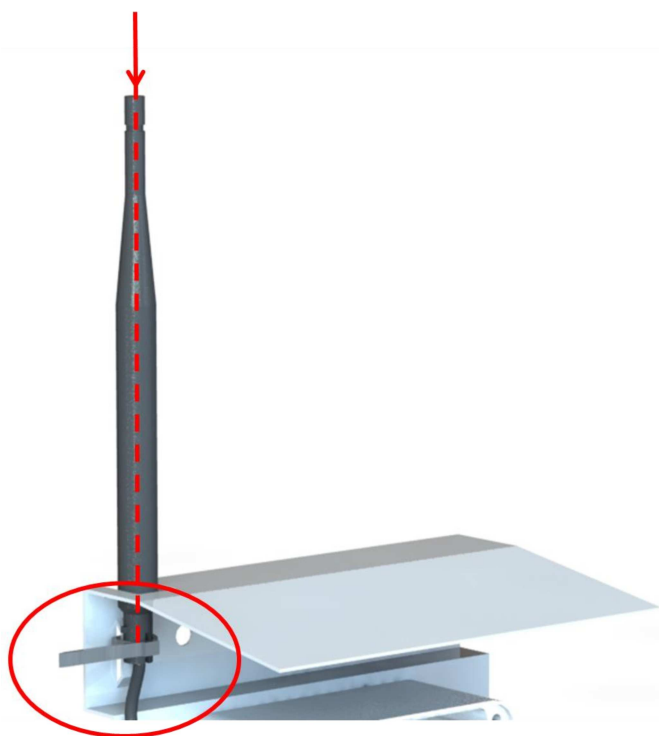


BOLTS: 2x cross-head screw M5

The master support plate has to be fixed on each inverter cabin.

Once the master box is fixed, insert the wireless antenna in the hole on the top roof of the master support plate and fix it by means of a cable tie, passing through the channel below.

Then, make sure that the wire of the antenna fall almost vertical and fix it to the lateral hole on the master support plate by means of the other cable tie, as indicated in the figure below.



For cabling, use the PG indicated in the figure below.



- Antenna
- RS 485 + 24 V

ANNEX E

E – ZINC RENOVATION ON DAMAGED PILES

After the cutting procedure, or more generally to those situations where damages caused a coating removal that could compromise the compliance to ISO 1461, it is important to restore the original galvanization resistance of piles, offering a sufficient sacrificial cathodic protection.

The uncoated parts of the Omega Pile to be evaluated must be checked with naked eye seeking for areas with zinc removal, including those where the piledriver hits. Identified areas with apparent presence of steel unprotected must be renovated. Following ISO 1461: 6.3 clause, the renovation treatment should take place when the uncoated areas not exceed 0,5% of the total surface area or if there are uncoated areas not exceeding 10 cm². (As example, the limits are respected following the above cutting and machining procedure)

The international standard ISO 1461 (item 6.3 and its Annex C) describes the correct approach and materials of zinc application on areas to be renovated, such as zinc spraying conforms ISO 2063, zinc-rich paint conforms ISO 3549, zinc-paste or zinc alloy stick products.

An example of zinc restoration is shown in the photo below.

