GFT GROUND FIXED TILT

INSTALLATION GUIDE

UNIRAC Code-Compliant Installation Manual

© 2021 by Unirac, Inc. All rights reserved.

UNIRAC welcomes input concerning the accuracy and user-friendliness of this publication. Please write to publications@unirac.com.

PUB2024JUL12

GFT GROUND FIXED TILT

INSTALLATION GUIDE

TABLE OF CONTENTS

SYSTEM COMPONENTS 1-3
STANDARD END & MID CLAMP ASSEMBLIES 4
RAIL CLIP & BEAM SPLICE 5
TOP CHORD & DIAGONAL PILE CONNECTIONS 6
INSTALLATION STEPS 7-28
ELECTRICAL CONSIDERATIONS 29-30
COMPATIBLE MODULES 31-34
APPENDIX A: UNIVERSAL AF CLAMPS INSTALLATION 35-36
APPENDIX B: PRO SERIES CLAMPS INSTALLATION 37-38

Safety Note: Cold formed steel components may have sharp edges after fabrication. Appropriate PPE should be worn to avoid injury.

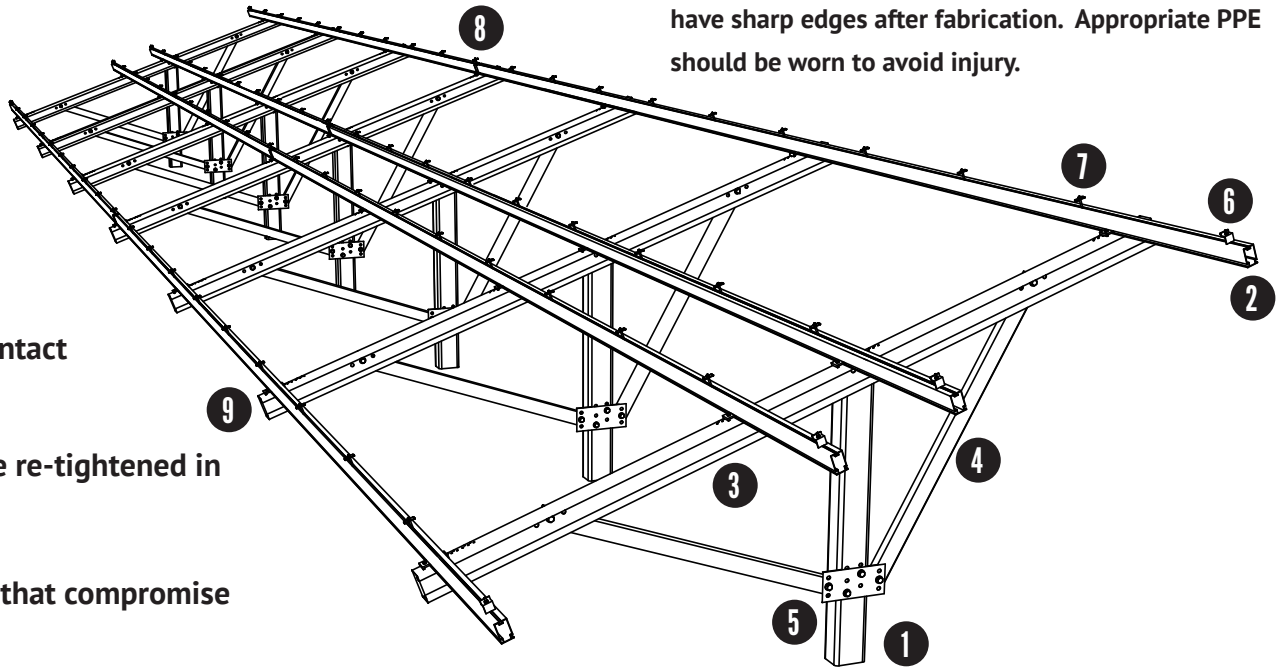
Safety Notes:

Cold formed steel components may have sharp edges after fabrication. Appropriate PPE should be worn to avoid injury.

Load ratings are project specific - please contact Unirac or refer to U-Builder.

Any loose components or fasteners shall be re-tightened in accordance with these instructions.

Any components showing signs of damage that compromise safety shall be replaced immediately.

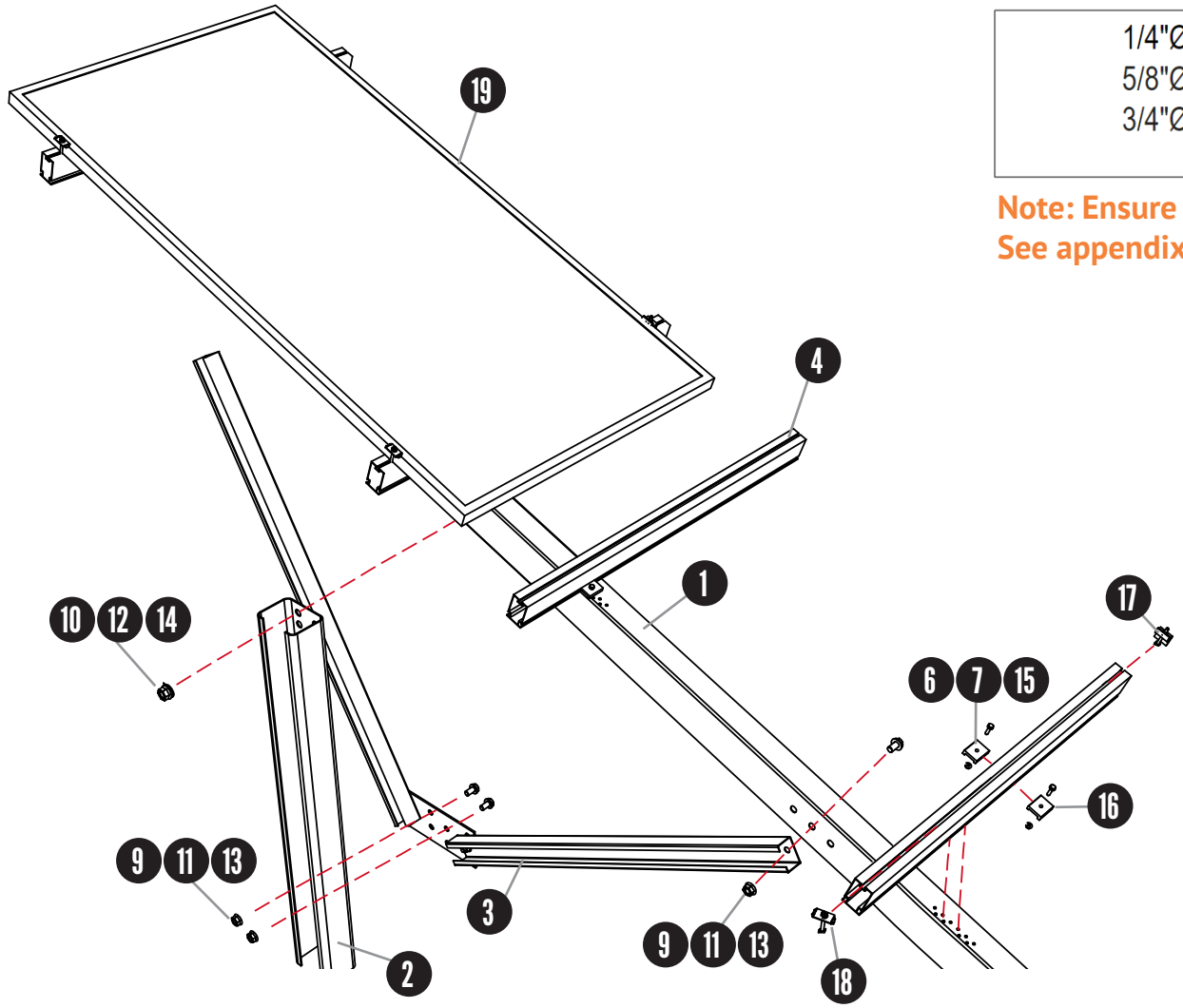


ITEM	COMPONENT	MATERIAL
1	Roll- Formed Steel Pile	4" or 4.5 " x 6" C Shape (Length Varies by Project)
2	Aluminum East-West Beam	Aluminum Beam with Continuous Slots for Adjustability
3	Roll-Formed Steel Top Chord	C Shape with Custom Hole Pattern for Adjustability
4	Roll-Formed Steel Diagonal Brace	C Shape
5	Steel Diagonal Brace Plate	Steel Plate with Custom Hole Pattern for Adjustability
6	End Clamp	End Clamp Assembly with T-Bolt
7	Mid Clamp	Mid Clamp Assembly with T-Bolt
8	Nested Splice Member	Internal Aluminum Splice Retained with Self-Tapping Screws
9	East-West Beam Clamp	Aluminum Extruded Clamp with Stainless Steel Hardware

TORQUE REQUIREMENTS FOR THE GFT PRODUCT:

1/4"Ø HARDWARE =	9 - 11 FT-LBS
5/8"Ø HARDWARE =	54 - 66 FT-LBS
3/4"Ø HARDWARE =	99 - 121 FT-LBS

Note: Ensure Torque wrenches have been calibrated.
See appendix for different clamp configurations



ITEM	COMPONENT
1	4.1" Top Chord Channel
2	6" x 4" or 4.5" C-Shape Pile
3	Diagonal Brace Assembly
4	3.25" x 2" East-West Aluminum Beam
5	Rail Splice - See page 6
6	Flat Washer 1/4"
7	Hex Flange Nut 1/4-20 Serrated
8	Rail splice connection - See page 6
9	Flat Washer 5/8"
10	Flat Washer 3/4"
11	Hex Bolt 5/8-11" x 1-1/2"
12	Hex Bolt 3/4-10" x 1-1/2"
13	Hex Flange Nut 5/8-11 Serrated
14	Hex Flange Nut 3/4-10 Serrated
15	Hex Bolt 1/4-20 x 1"
16	East-West Rail Clip
17	Standard End Clamp Assembly
18	Standard Mid Clamp Assembly
19	PV Module (By Others)

GFT 4 RAIL COMPONENTS

S.No.	Part Number	Description
1	404001	GFT C-PILE, 12.5'
2	404002	GFT C-PILE, 15.0'
3	404004	GFT C-PILE, 10.5'
4	404037	GFT TOP CHORD CHANNEL 20/30 LF
5	404031	GFT DIAG BRACE ASSEMBLY 20D SR
6	404032	GFT DIAG BRACE ASSEMBLY 30D SR
7	404013	GFT ASSEMBLY HARDWARE 4-RAIL KIT
8	411166M	GFT RAIL 166" MILL
9	411246M	GFT RAIL 246" MILL
10	404014	KIT, GFT RAIL SPLICE W/ HDWR
11	404015	GFT WIRE MANAGEMENT CLIP
12	404020	GFT RAIL SUPPLEMENTAL HDWR 4-RAIL
13	GFT-CAP	GFT RAIL END CAP, UV-BLK

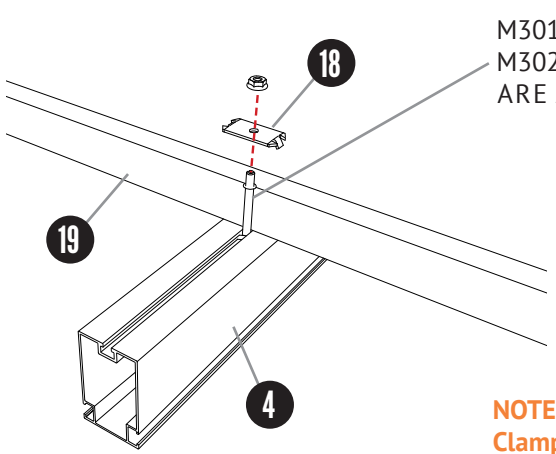
SYMBOL	DESCRIPTION
AL	ALUMINUM
CLR	CLEAR ANODIZED
DRK	DARK BRONZE ANODIZED
SS	STAINLESS STEEL
DRK SS	BLACK OXIDE COATED STAINLESS STEEL

LETTER	SUPPORTED MODULE THICKNESS
B	30MM -32MM
C	33MM -36MM
D	38MM -40MM
K	39MM -41MM
F	45MM -47MM
E	50MM -51MM

MID CLAMPS AND END CLAMPS

S.NO.	PART NUMBER	DESCRIPTION
1	302021C	SM ENDCLAMP B CLR AL
2	302021D	SM ENDCLAMP B DRK AL
3	302022C	SM ENDCLAMP C CLR AL
4	302022D	SM ENDCLAMP C DRK AL
5	302023C	SM ENDCLAMP D CLR AL
6	302023D	SM ENDCLAMP D DRK AL
7	302024C	SM ENDCLAMP E CLR AL
8	302024D	SM ENDCLAMP E DRK AL
9	302025C	SM ENDCLAMP F CLR AL
10	302025D	SM ENDCLAMP F DRK AL
11	302026C	SM ENDCLAMP K CLR AL
12	302026D	SM ENDCLAMP K DRK AL
13	302027C	SM BND MIDCLAMP BC SS
14	302027D	SM BND MIDCLAMP BC DRK SS
15	302028C	SM BND MIDCLAMP EF SS
16	302028D	SM BND MIDCLAMP EF DRK SS
17	302029C	SM BND MIDCLAMP DK SS
18	302029D	SM BND MIDCLAMP DK DRK SS
19	302030D	SM MIDCLAMP PRO DRK
20	302030M	SM MIDCLAMP PRO MILL
21	302035M	SM ENDCLAMP PRO W/CAP
22	302045D	UNIVERSAL AF MID CLAMP DRK
23	302045M	UNIVERSAL AF MID CLAMP MILL
24	302050D	UNIVERSAL AF END CLAMP DRK
25	302050M	UNIVERSAL AF END CLAMP MILL

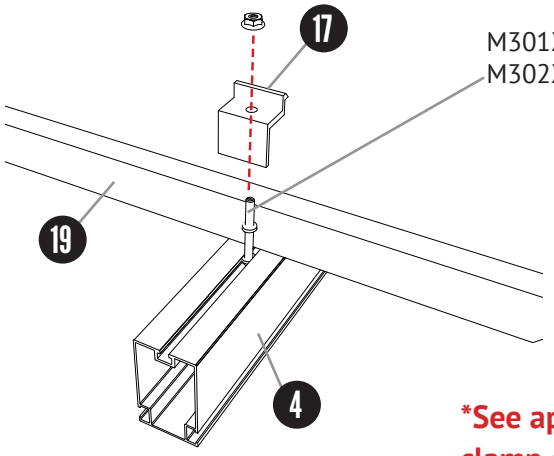
Standard Mid Clamp Assembly with T-Bolt



M301XX: T-BOLT 1/4-20 OR
M302XX: T-BOLT SERR. 1/4-20
ARE ACCEPTABLE

NOTE - Standard Series Mid and End Clamps are single use only

Standard End Clamp Assembly with T-Bolt



M301XX: T-BOLT 1/4-20 OR
M302XX: T-BOLT SERR. 1/4-20

***See appendix for different clamp configurations**

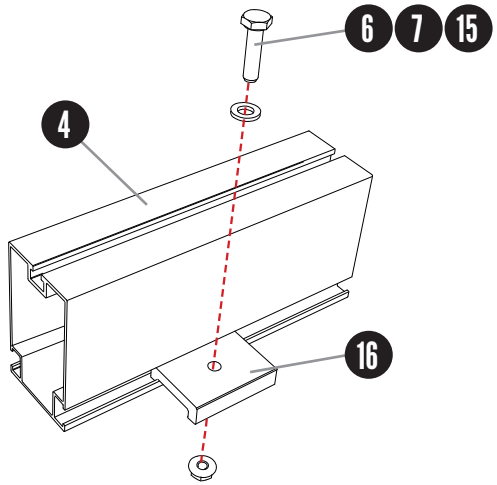
Mid Clamp Assembly With T-Bolt

ITEM	COMPONENT	MATERIAL
4	3.25" x 2" East-West Aluminum Beam	Aluminum Alloy 6005A-T61, 6351-T5 or 6061-T6
18	Mid Clamp	Stainless Steel, 301,302, or 304, 1/4 Hard, Mill Finish
19	PV Module (By Others)	As per Manufacturer
SEE DWG	1/4-20 T-Bolt (Serrated or Non-Serrated)	300 Stainless Steel (301 Preferred)
SEE DWG	1/4-20 Serrated Flange Nut	Stainless Steel ASTM F594

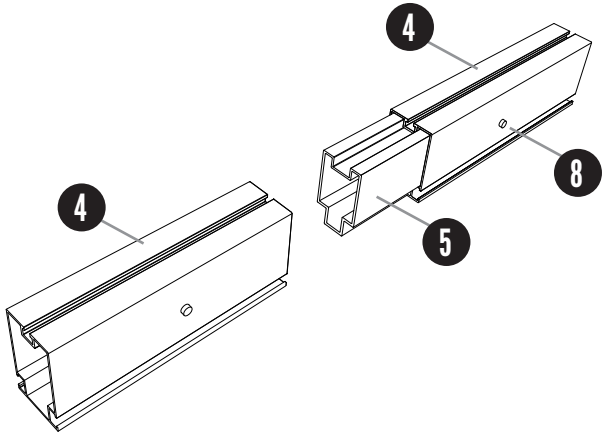
End Clamp Assembly With T-Bolt

ITEM	COMPONENT	MATERIAL
4	3.25" x 2" East-West Aluminum Beam	Aluminum Alloy 6005A-T61, 6351-T5 or 6061-T6
17	End Clamp	Stainless Steel, 301,302, or 304, 1/4 Hard, Mill Finish
19	PV Module (By Others)	As per Manufacturer
SEE DWG	1/4-20 T-Bolt (Serrated or Non-Serrated)	300 Stainless Steel (301 Preferred)
SEE DWG	1/4-20 Serrated Flange Nut	Stainless Steel ASTM F594

East-West Rail Clip



East-West Beam Splice



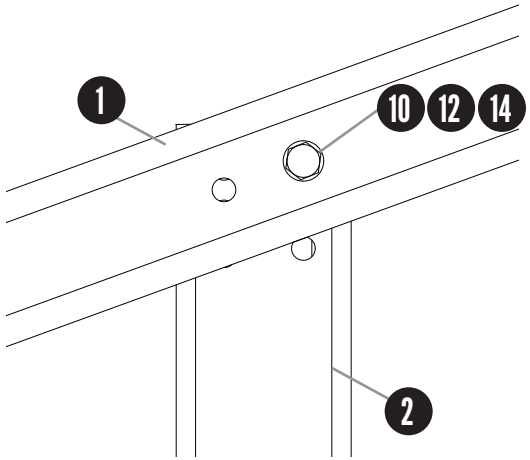
East-West Rail Clip

ITEM	COMPONENT	MATERIAL
4	3.25" x 2" East-West Aluminum Beam	Aluminum Alloy 6005A-T61, 6351-T5 or 6061-T6
6	Flat Washer 1/4"	Stainless Steel ASTM F594
7	Hex Flange Nut 1/4-20 Serrated	302HQ 18/8 Stainless Steel Austenitic 300 Series
15	Hex Bolt 1/4-20 x 1"	302HQ 18/8 Stainless Steel Austenitic 300 Series
16	East-West Rail Clip	Aluminum Alloy 6005A-T61, 6351-T5 or 6061-T6

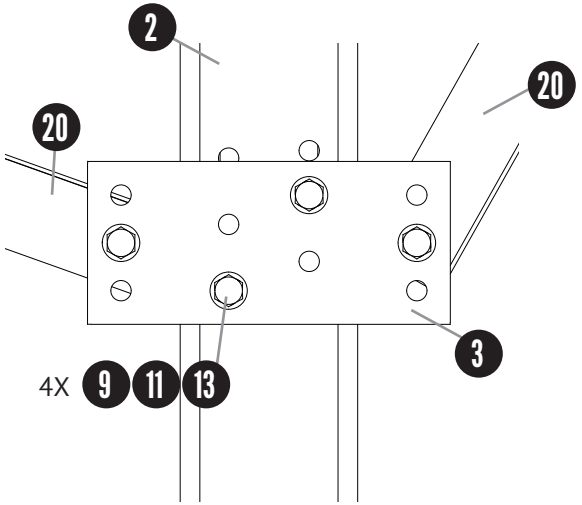
East-West Beam Splice

ITEM	COMPONENT	MATERIAL
4	3.25" x 2" East-West Aluminum Beam	Aluminum Alloy 6005A-T61, 6351-T5 or 6061-T6
5	East-West Beam Splice Insert	Aluminum Alloy 6005A-T61, 6351-T5 or 6061-T6
8	1/4" x 20 Self Drilling Screw (Buildex)	ASTM A449/ SAE J429 (Similar Properties Confirmed by testing)

Top Chord to Pile Connection



Diagonal Brace Plate to Pile Connection

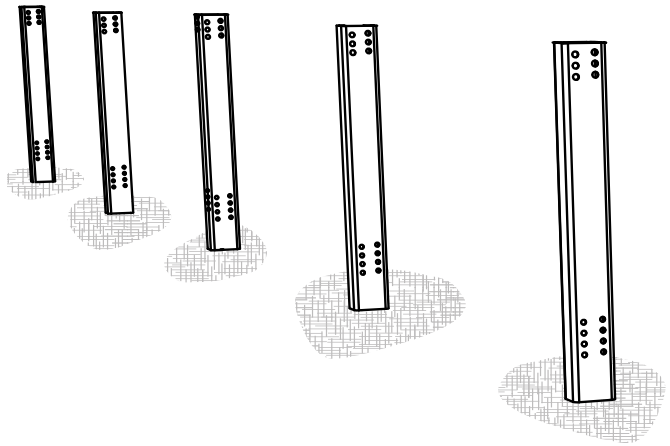


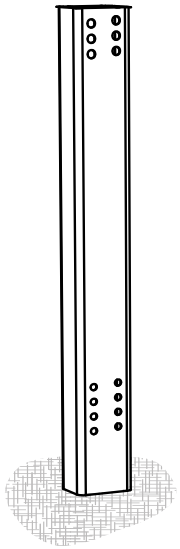
Top Chord to Pile Connection

ITEM	COMPONENT	MATERIAL
1	4.1" Top Chord Channel	Cold Rolled ASTM A653 HSLAS
2	6" x 4 or 4.5" C-Shape Pile	Cold Rolled ASTM A653 HSLAS
10	Flat Washer 3/4"	SAE Type A Narrow
12	Hex Bolt 3/4-10 x 1-1/2"	SAE J429
14	Hex Flange Nut 3/4-10 Serrated	SAE J429

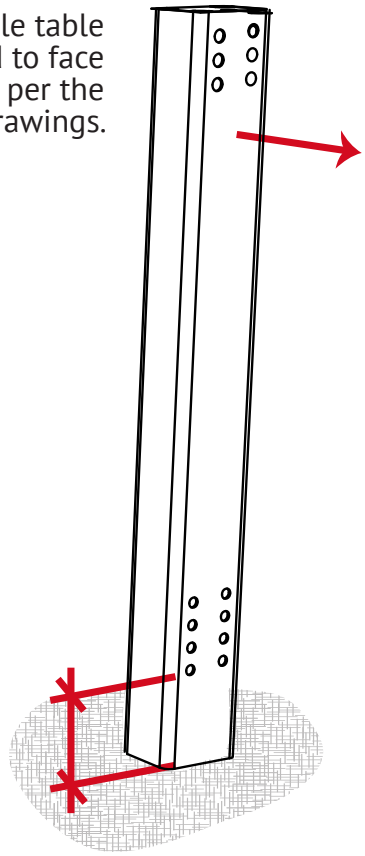
Diagonal Brace Plate to Pile Connection

ITEM	COMPONENT	MATERIAL
2	6" x 4 or 4.5" C Shape Pile	Cold Rolled ASTM A653 HSLAS
3	Diagonal Brace Plate	ASTM A36 or ASTM A653
9	Flat Washer 5/8"	SAE Type A Narrow
11	Hex Bolt 5/8-11 x1-1/2"	SAE J429
13	Hex Flange Nut 5/8-11 Serrated	SAE J429
20	Diagonal Brace	Cold Rolled ASTM A653 HSLAS



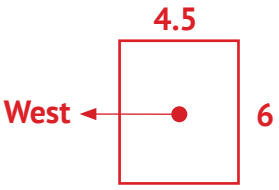


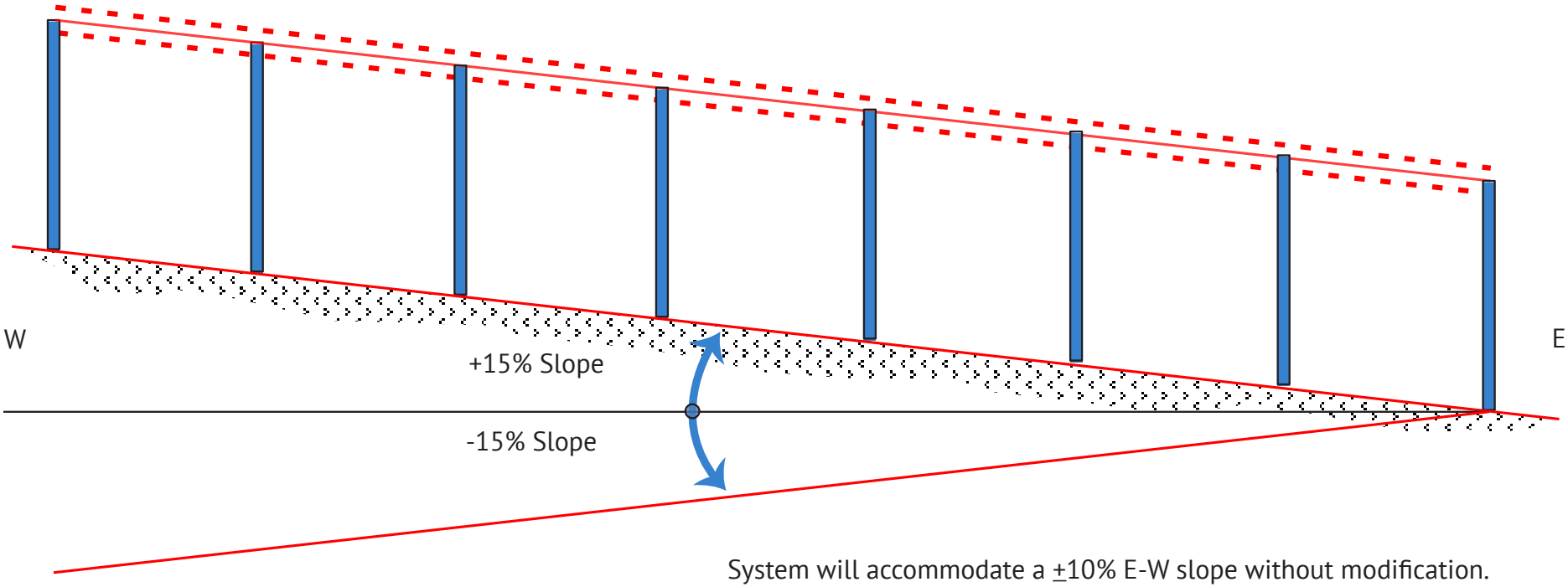
All piles within single table must be oriented to face the same direction per the construction drawings.



Hole height above grade per construction drawings.

Note:
C-Piles must be installed with C open to the West.

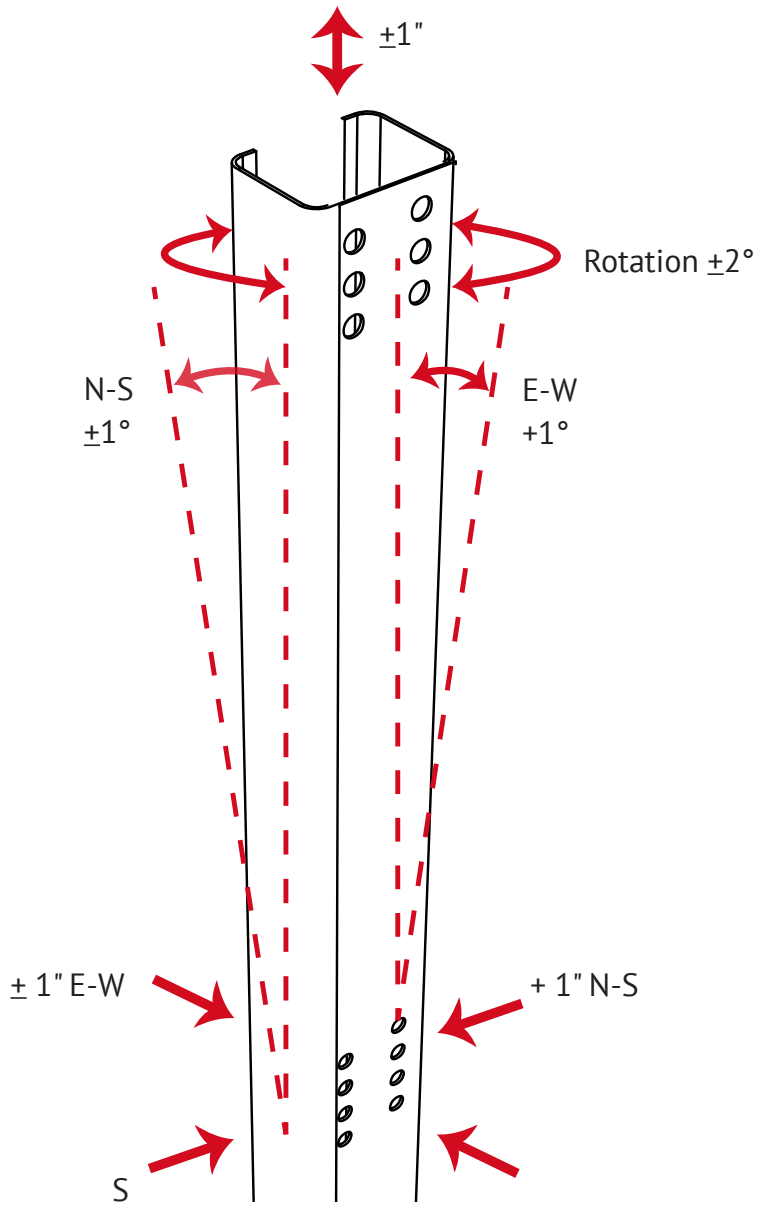




System will accommodate a ±10% E-W slope without modification.

- Plumb tolerances apply regardless of slope.
- Pile position tolerances apply relative to nominal finish grade line.

Note:
The GFT system has been installed at an E-W slope of 15%. This is achievable, but requires additional effort to ensure that holes align for bolted connection.

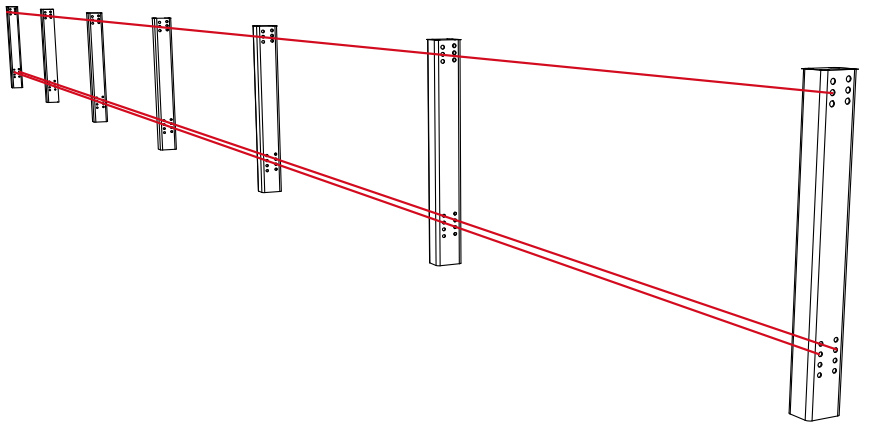

±1"
Rotation ±2°
N-S
±1°
E-W
+1°
± 1" E-W
+ 1" N-S
S

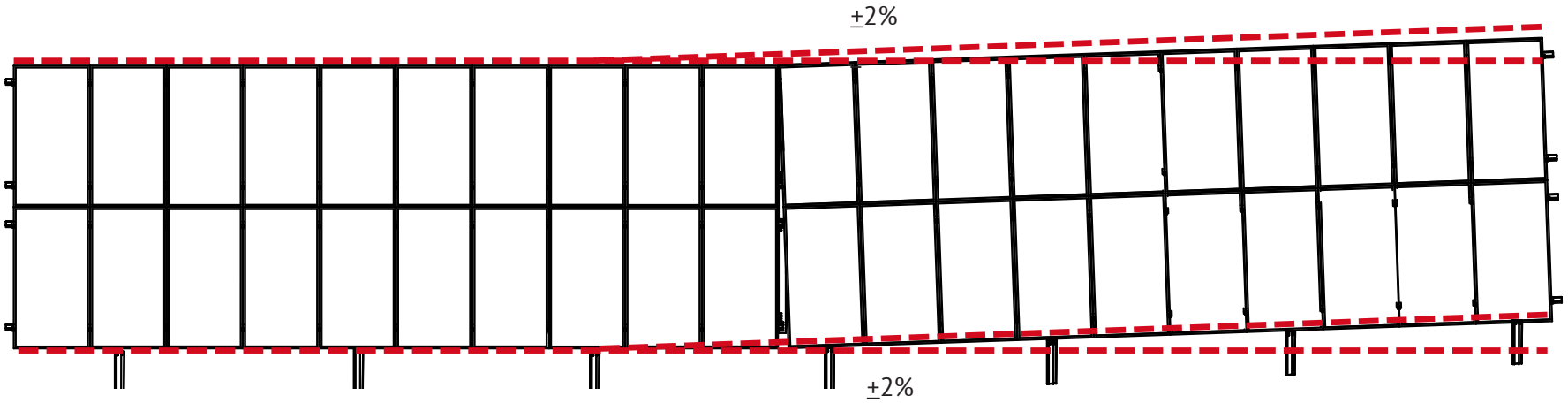
ALIGN ATTACHMENT HOLES ON PILES

1. Align target hole locations in all piles (within tables and table to table) using laser or string line.

2. Determine if adjustments are needed up or down (hole patterns allow for + 1-1/2" adjustments in 3/4" increments per instruction on following pages).

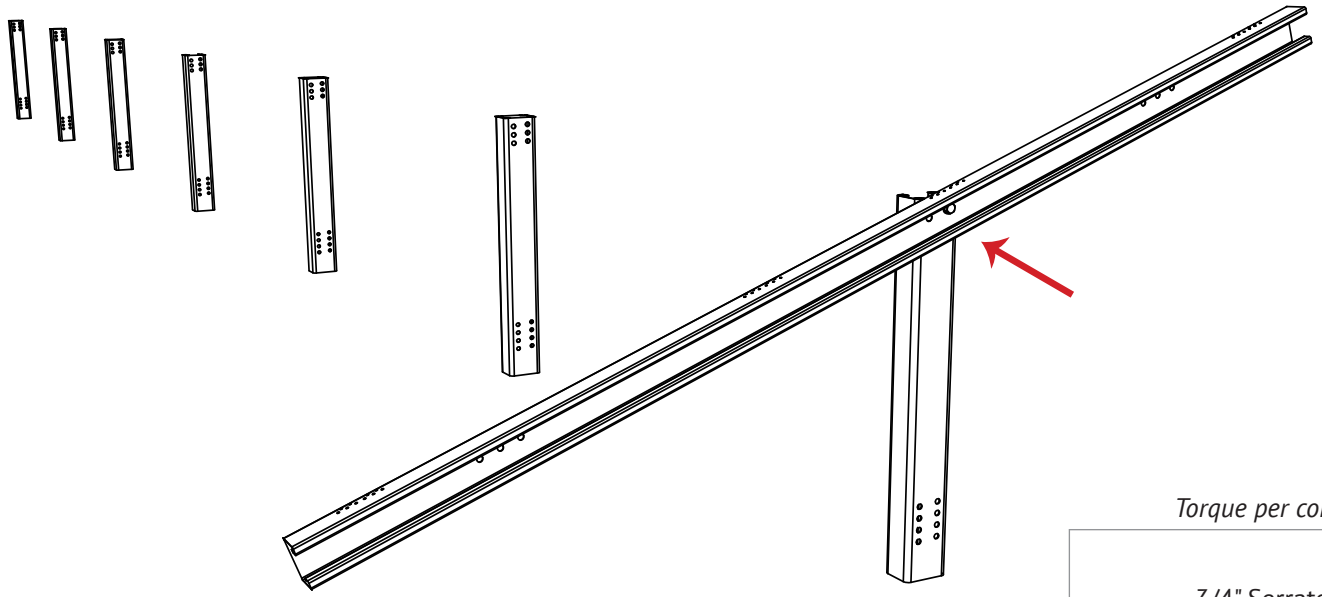
3. Mark holes to be used for top chord and diagonal brace plate attachments prior to installing.



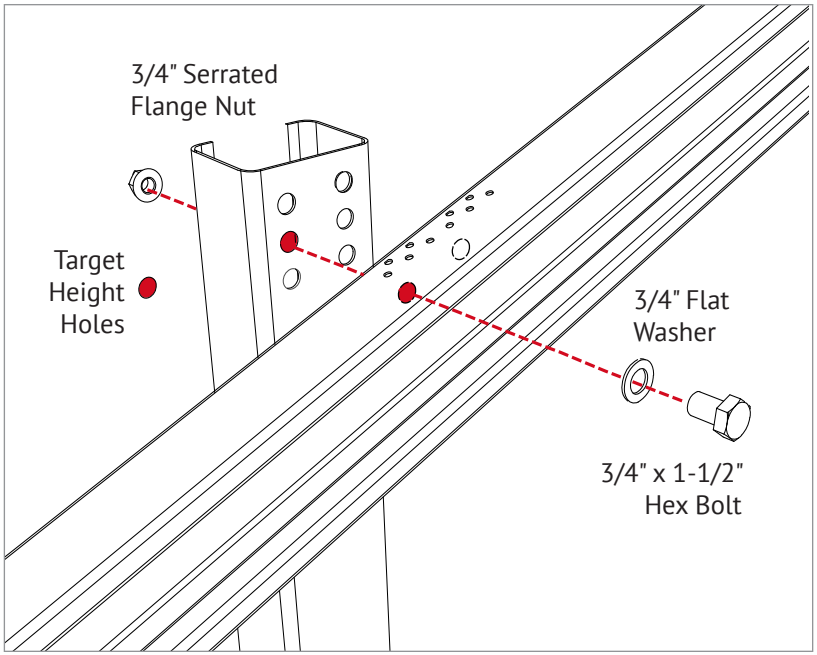


The system is capable of being aligned to the target string or laser line using the adjustment holes when piles are placed within allowable tolerances. Each table will however accommodate a 2% deviation from the target line as shown without impact to structural integrity.

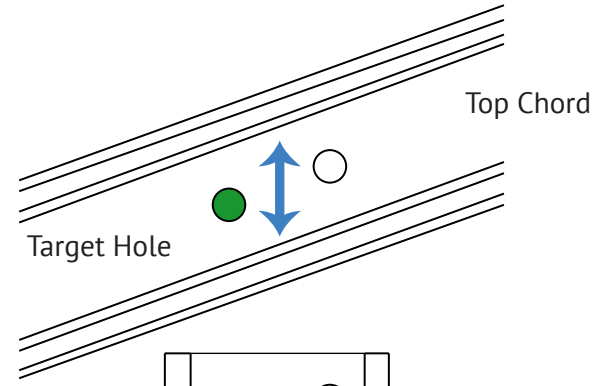
ATTACH TOP CHORD TO PILE

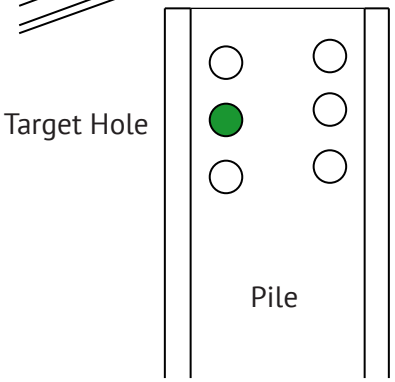


Install hardware snug tight.
Torque per construction drawings after final adjustments.



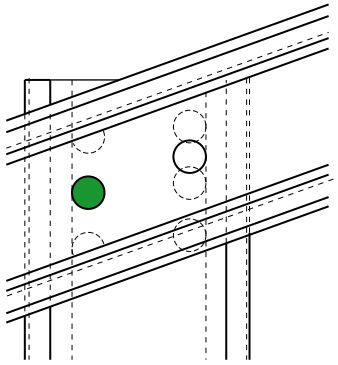
Target Height





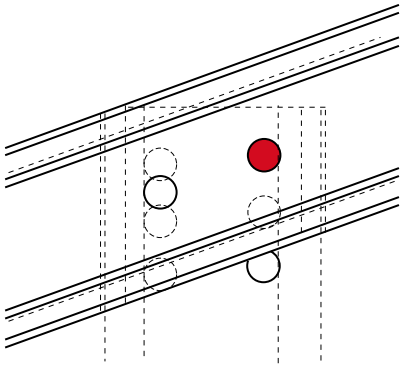
Move top chord up or down (not horizontally) as needed to adjust height in 3/4" increments.

Use single 3/4" bolt (nut and washer) at one of the locations shown.

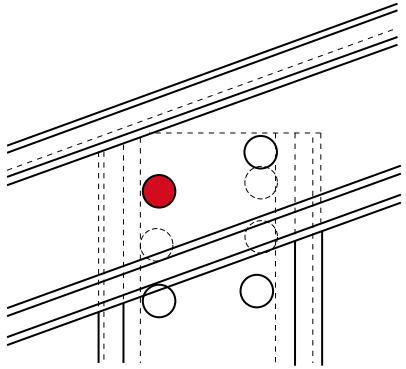


Target Height

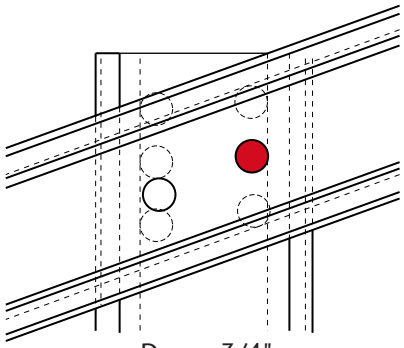
Adjustment Locations (Single 3/4" Bolt)



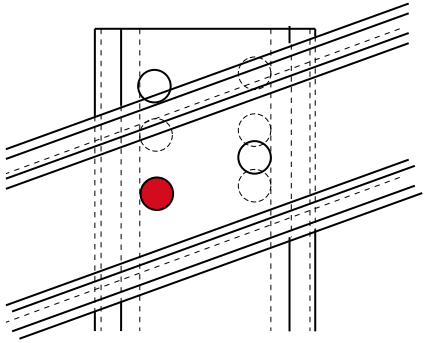
Up 3/4"



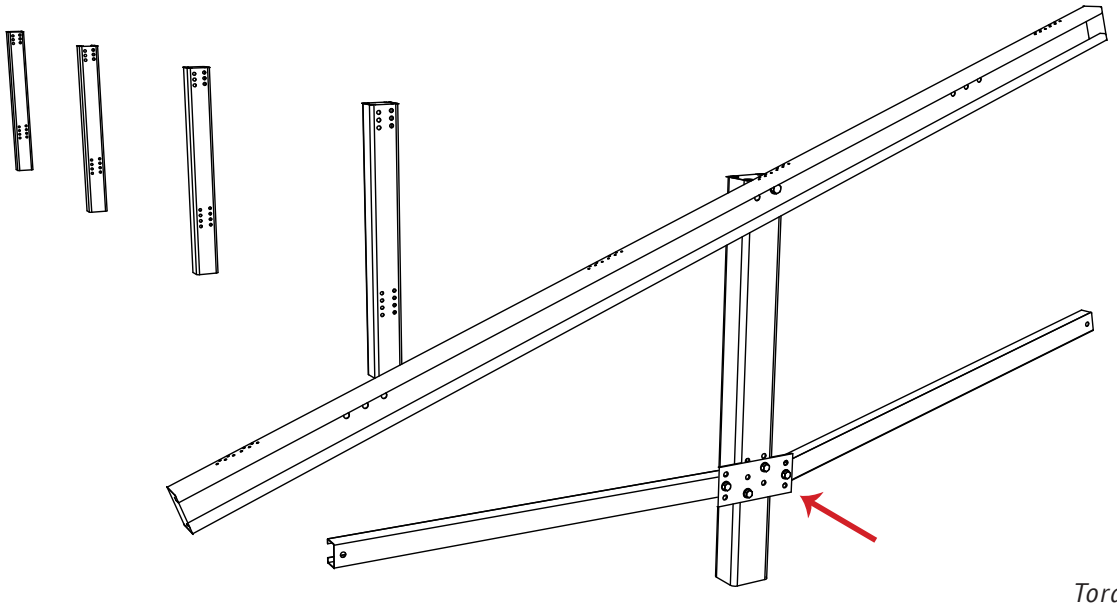
Up 1-1/2"



Down 3/4"



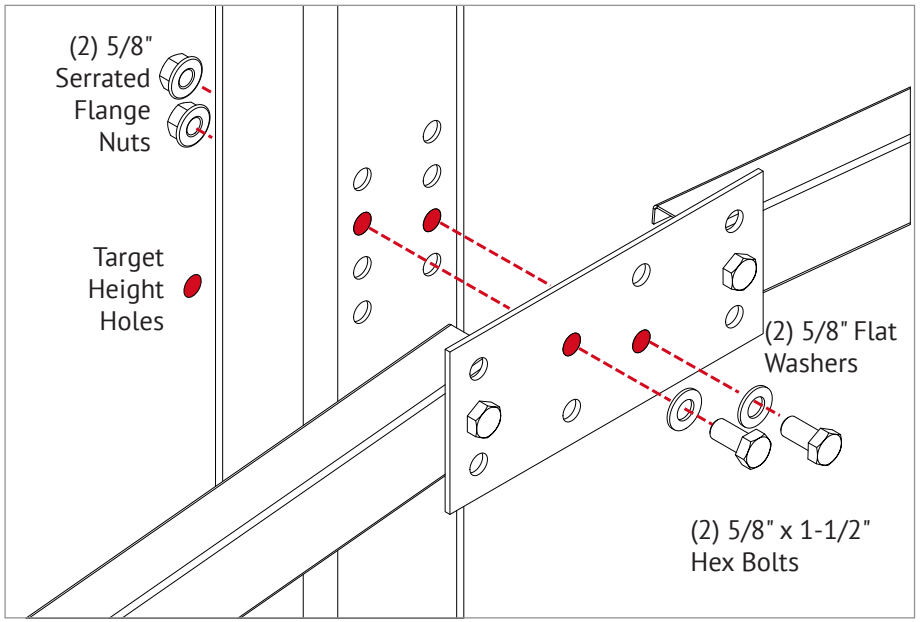
Down 1-1/2"



Diagonal Brace Assembly

Install hardware snug tight.

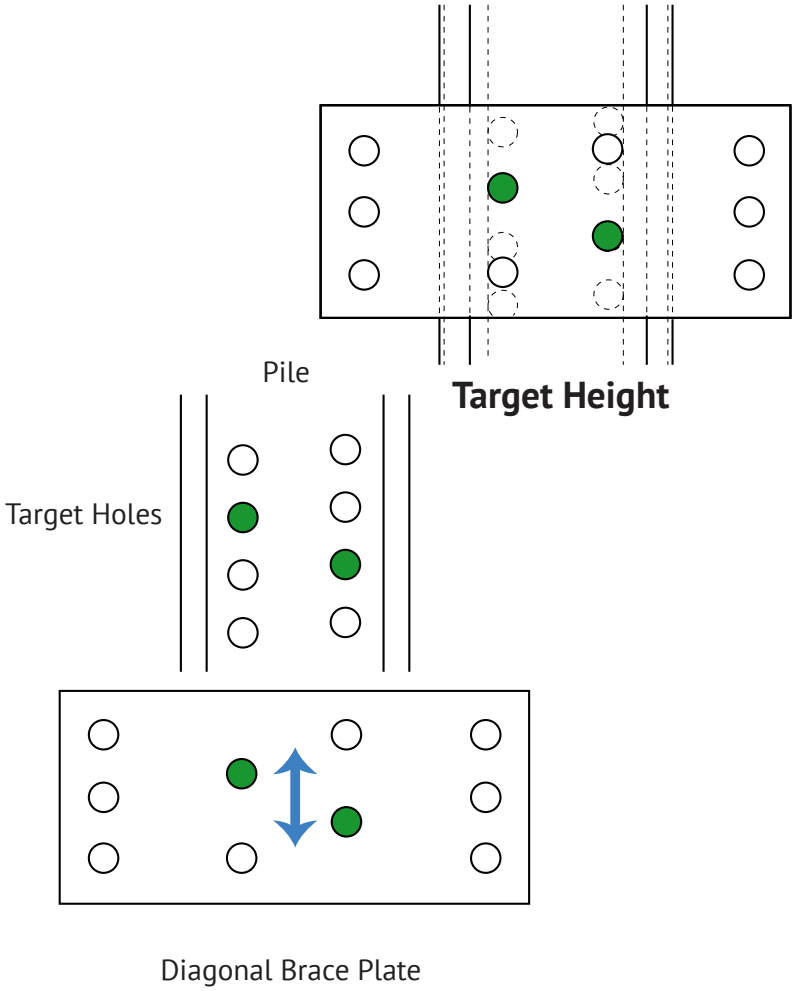
Torque per construction drawings after final adjustments.



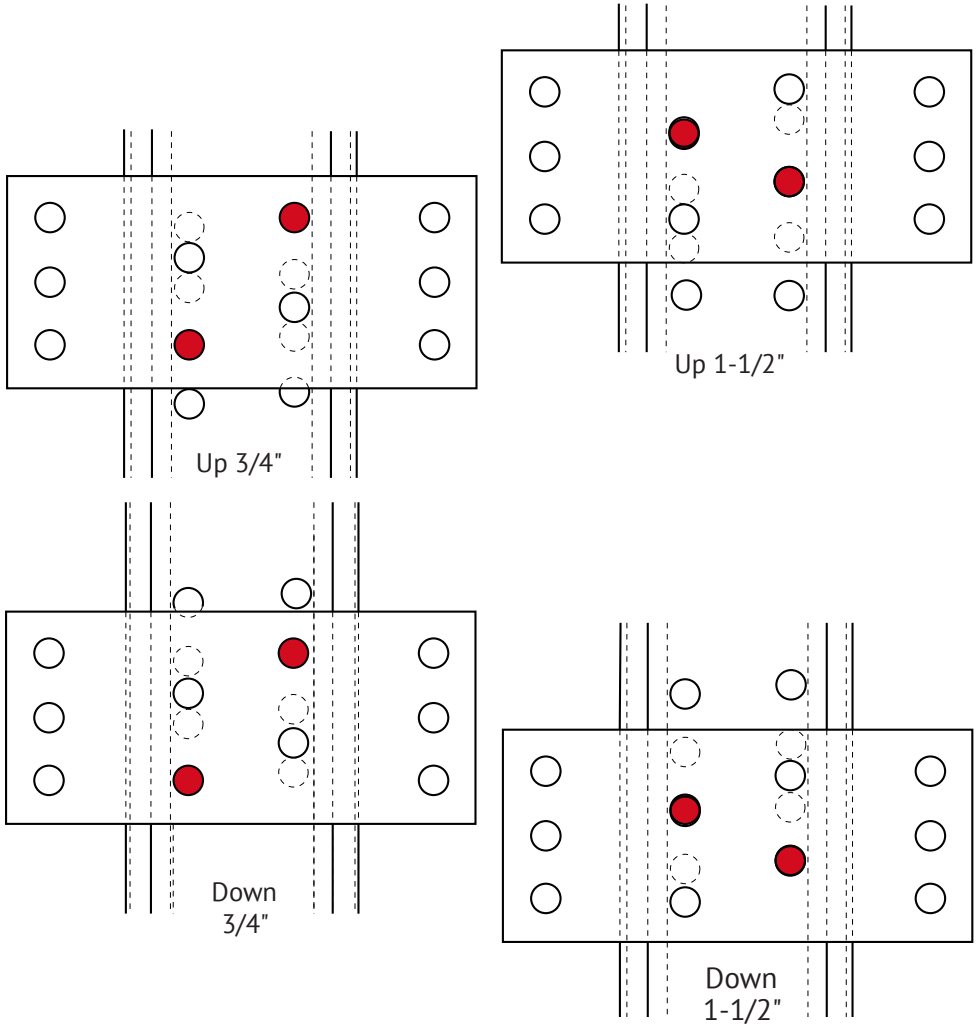
Target Height

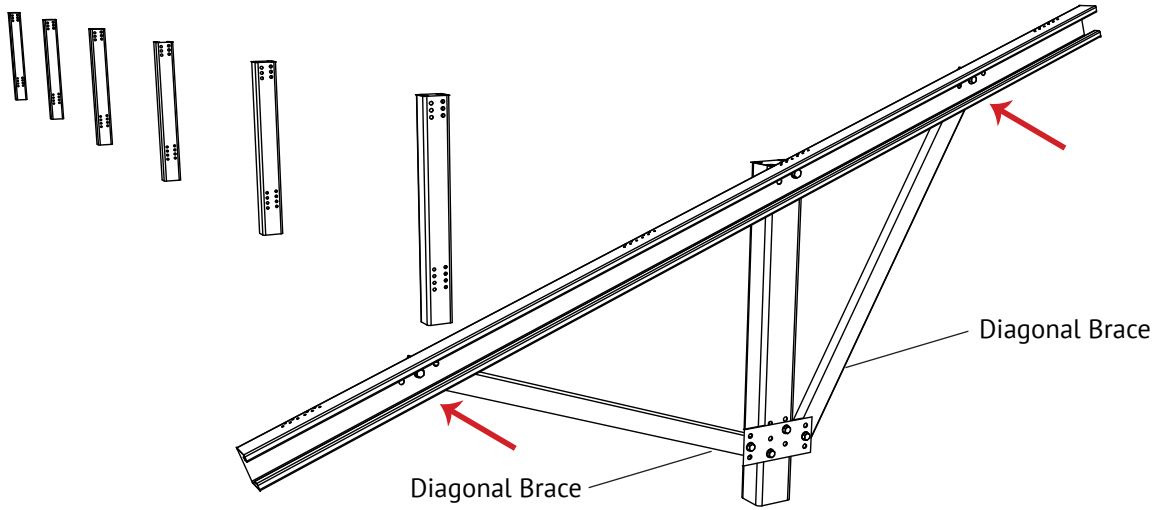
Move diagonal brace plate up or down (not horizontally) as needed to adjust height in 3/4" increments.

Use pair of 5/8" bolts (nuts and washers) at location shown.

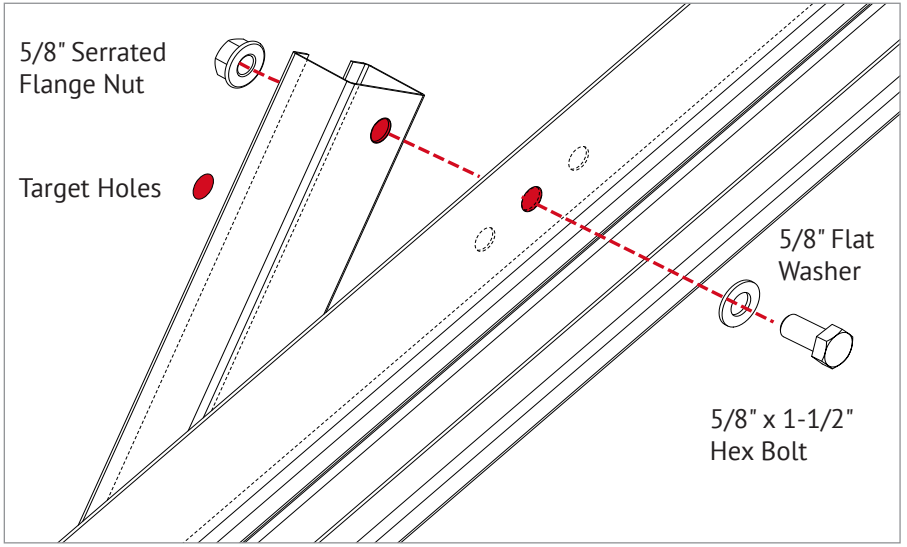


Adjustment Locations (Pair of 5/8" Bolts)

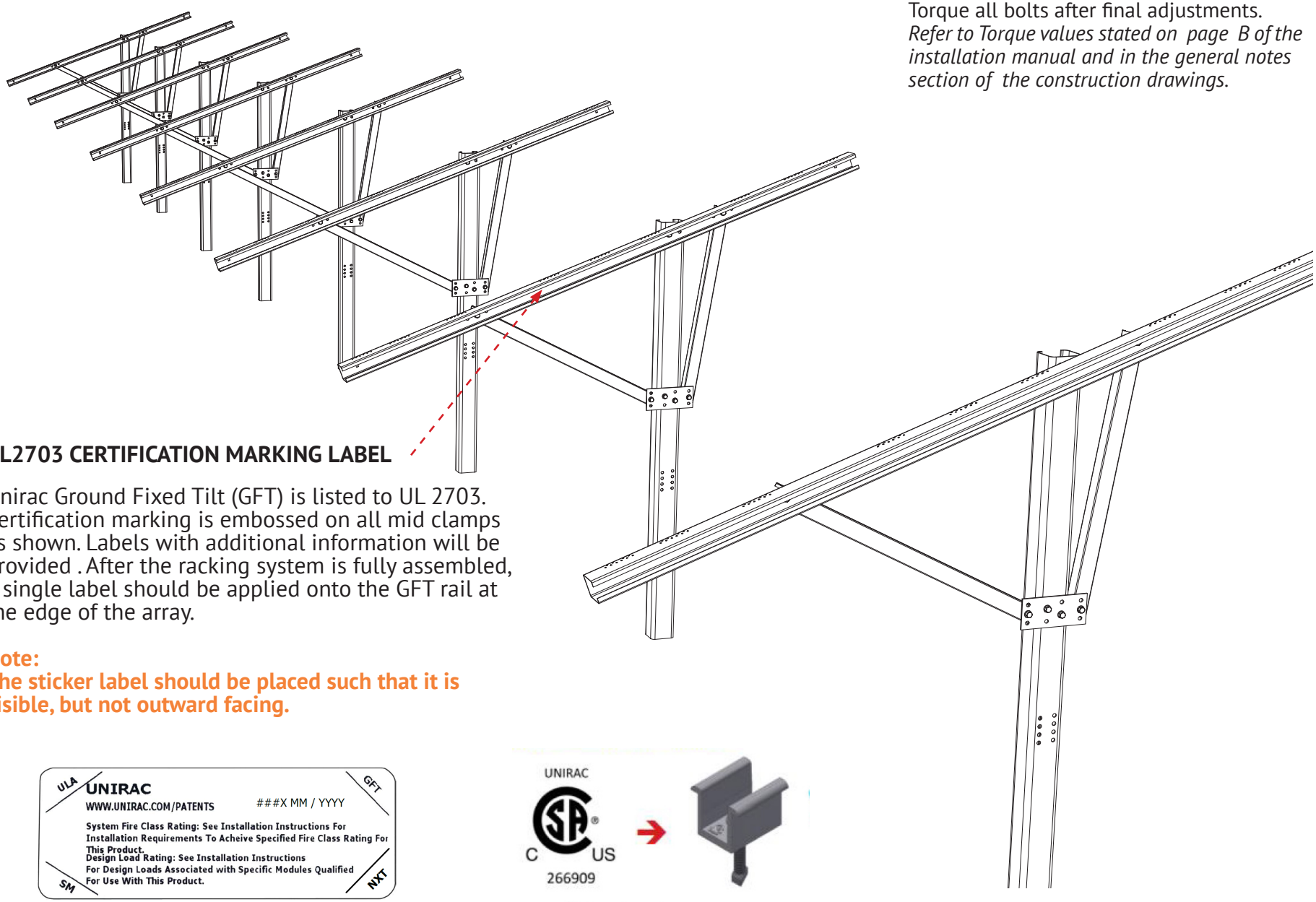




Install hardware snug tight.
Torque per construction drawings after final adjustments.



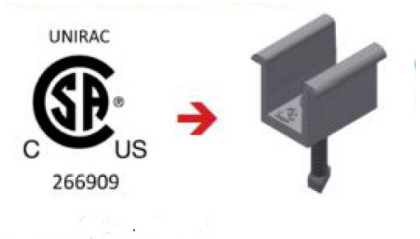
Torque all bolts after final adjustments.
Refer to Torque values stated on page B of the installation manual and in the general notes section of the construction drawings.

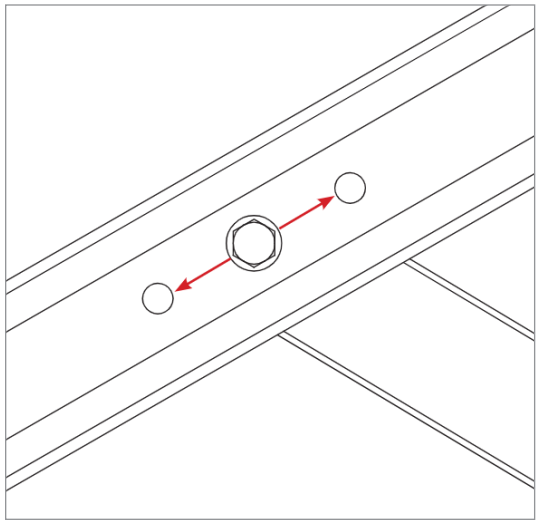


UL2703 CERTIFICATION MARKING LABEL

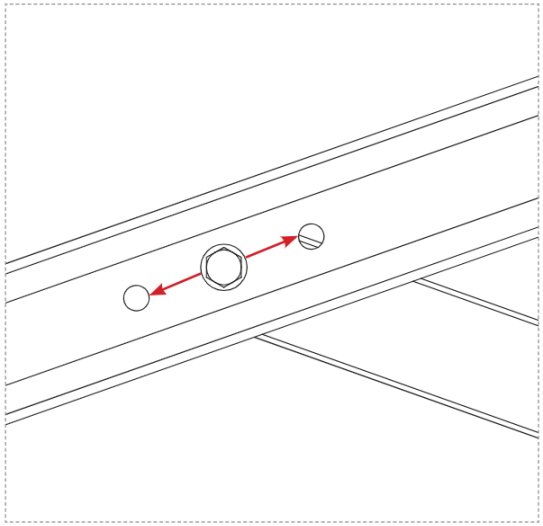
Unirac Ground Fixed Tilt (GFT) is listed to UL 2703. Certification marking is embossed on all mid clamps as shown. Labels with additional information will be provided . After the racking system is fully assembled, a single label should be applied onto the GFT rail at the edge of the array.

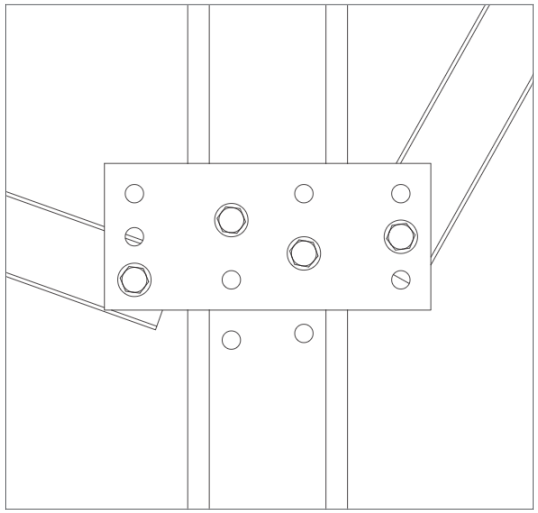
Note:
The sticker label should be placed such that it is visible, but not outward facing.

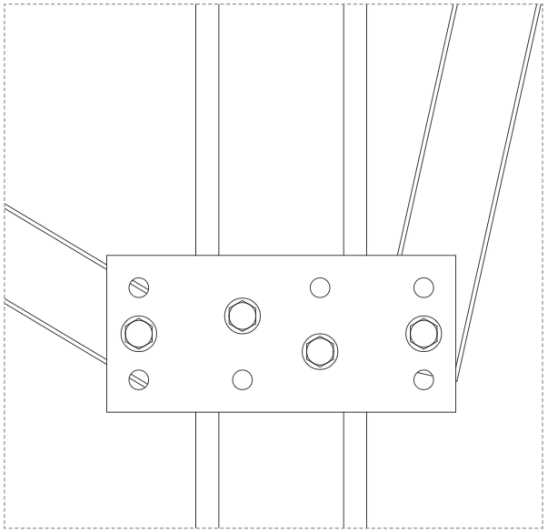




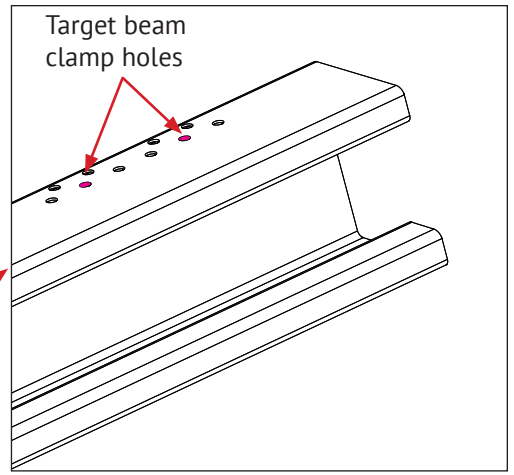
If required, additional minor adjustment of top chord angle may be achieved by a combined repositioning of diagonal braces to adjacent holes in top chord and diagonal brace plate.

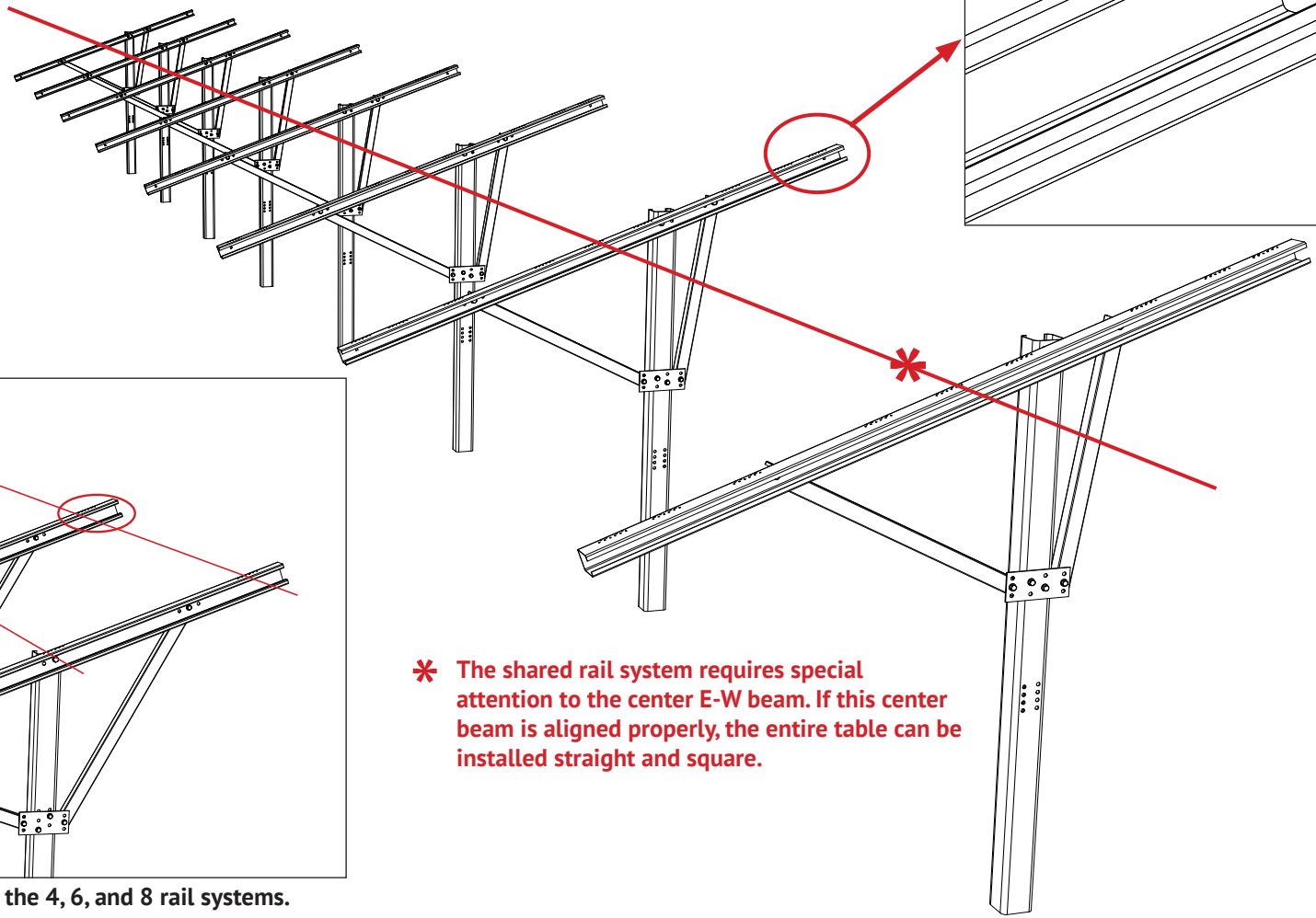


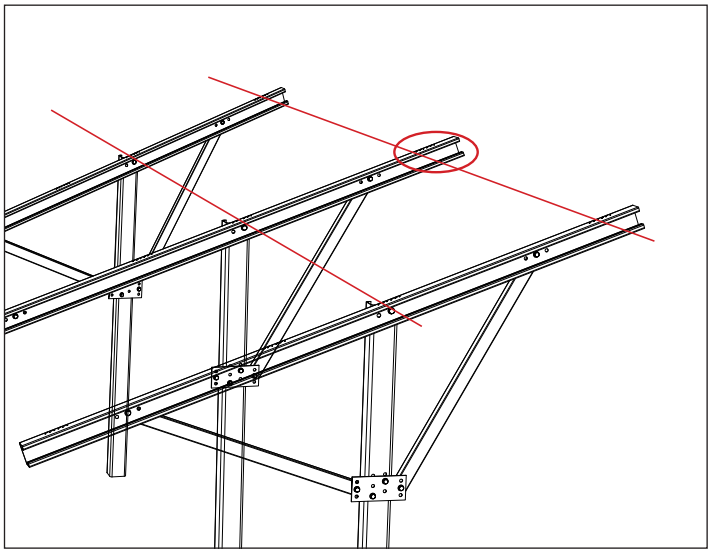




1. Align target hole locations using laser or string line.
2. Determine if adjustments are needed up or down. (Hole patterns allow for +1" adjustment in 1/2" increments per instruction on following pages).
3. 3. Mark holes to be used for attaching E-W beams prior to installing.







Determine hole locations for the 4, 6, and 8 rail systems.

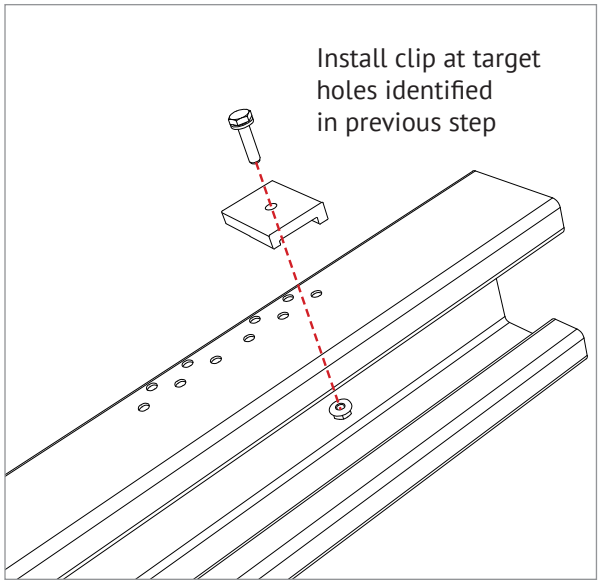
Note: Refer to construction drawings for N-S rail spans.

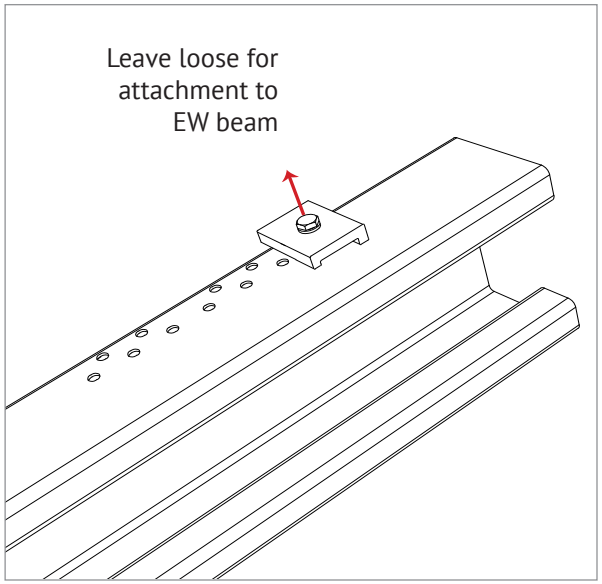
* **The shared rail system requires special attention to the center E-W beam. If this center beam is aligned properly, the entire table can be installed straight and square.**

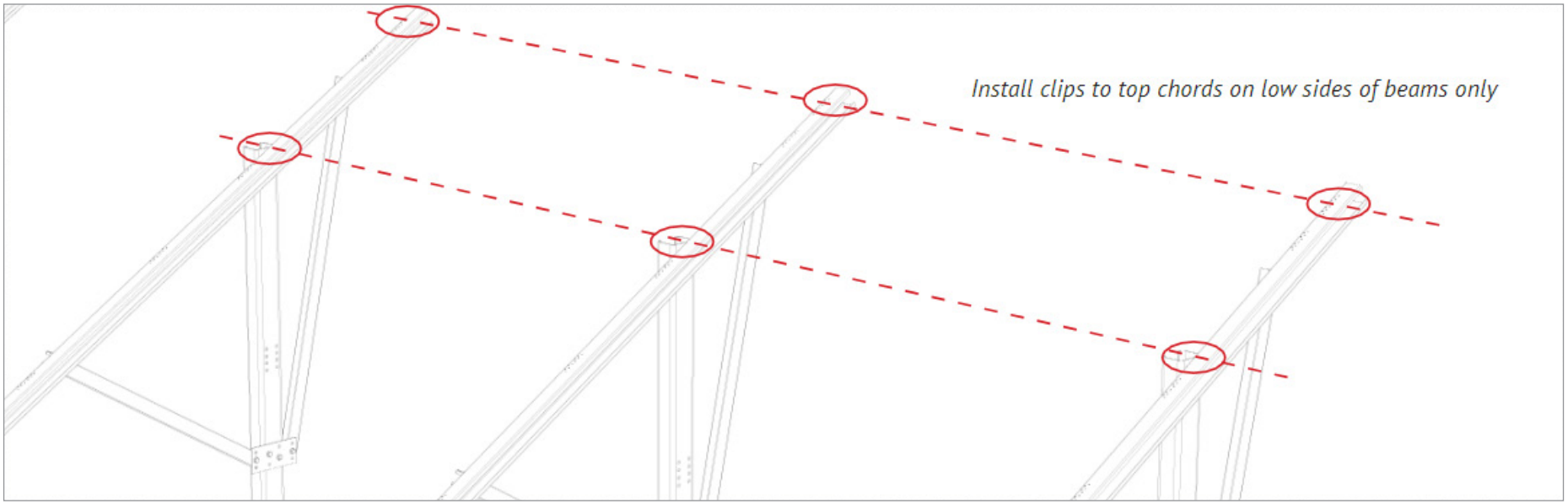
Anti-Seize

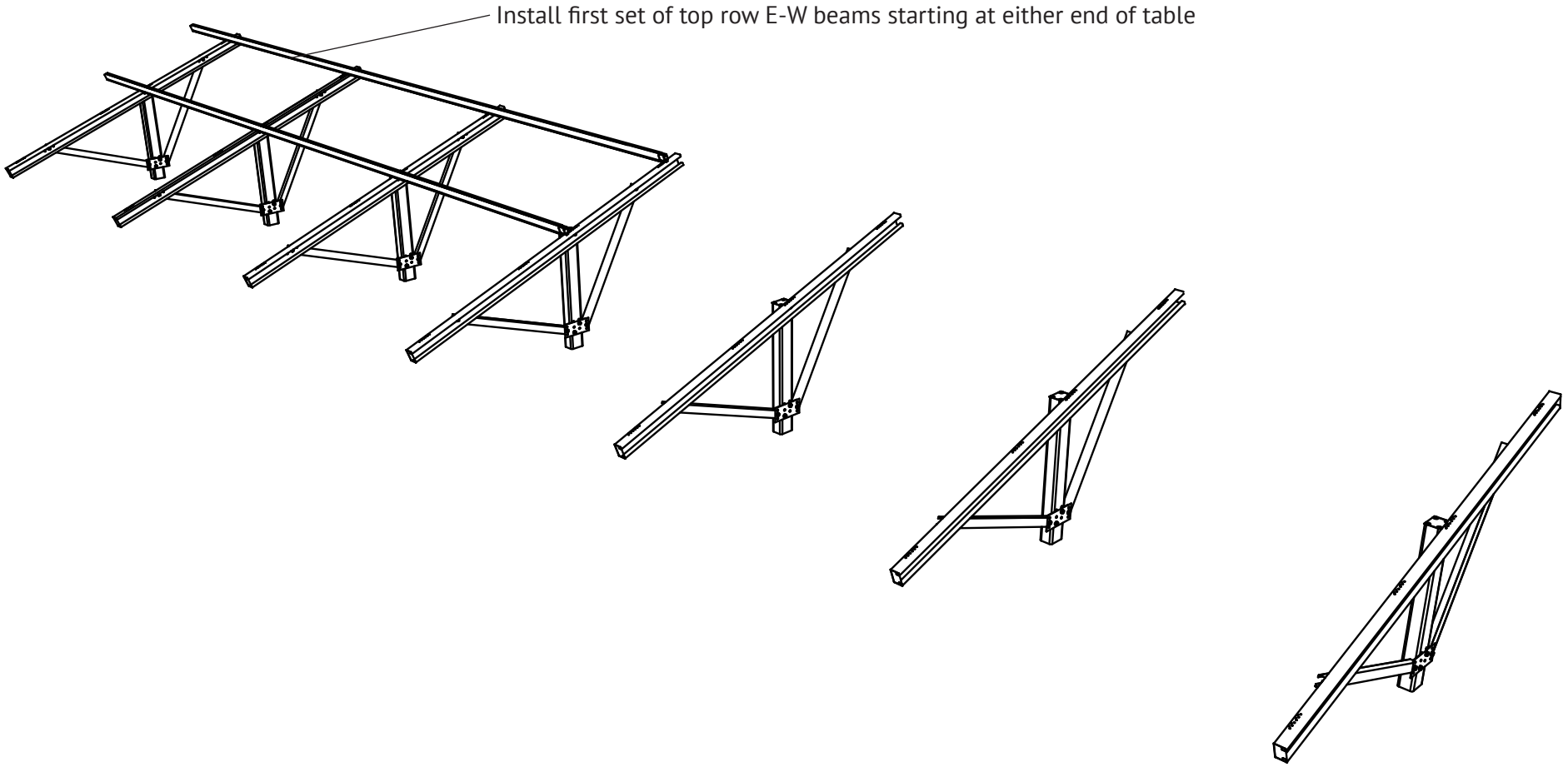
Stainless steel hardware can seize up, a process called galling. To significantly reduce its likelihood:

1. Apply minimal lubricant to bolts only where indicated in installation process, preferably Anti-Seize commonly found at auto parts stores (Anti-seize has been factory applied to mid clamp bolts)
2. Shade hardware prior to installation,
3. Avoid spinning stainless nuts onto bolts at high speed.

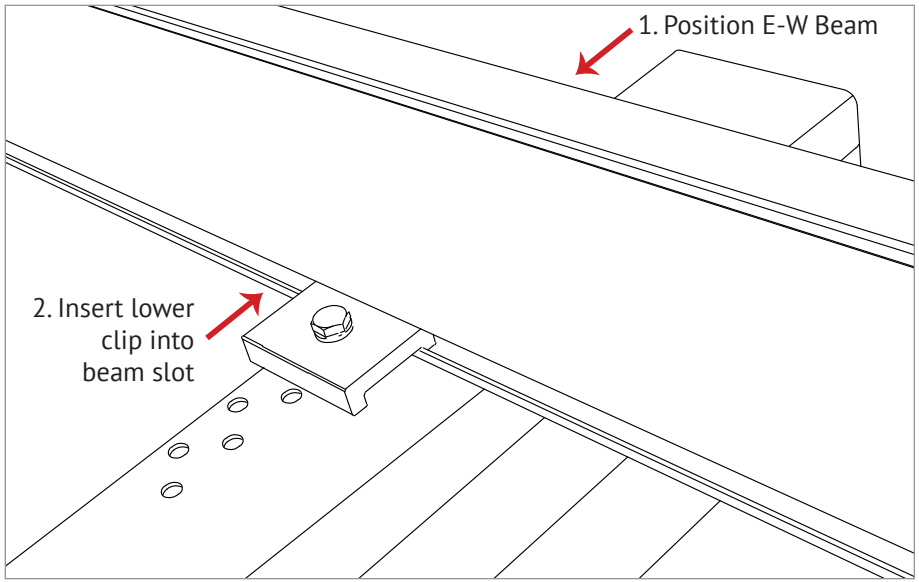


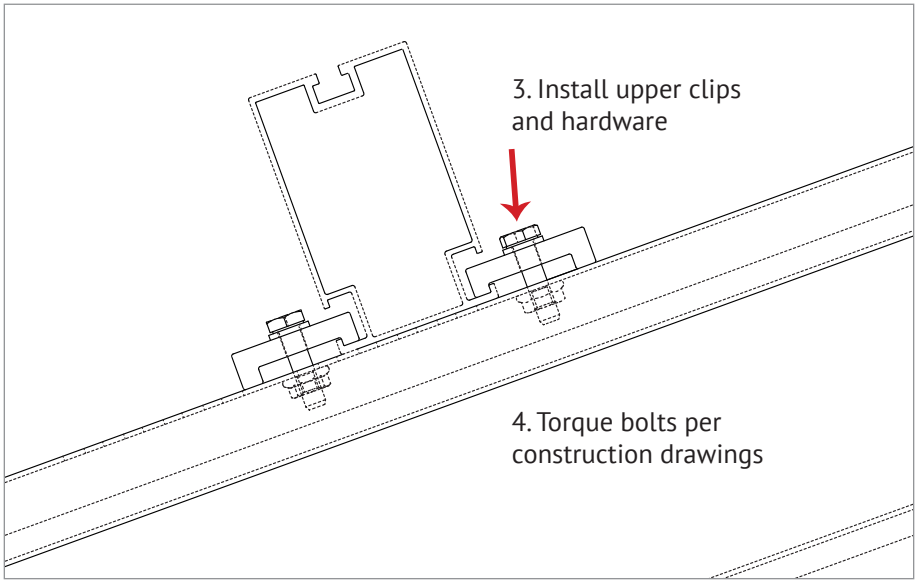


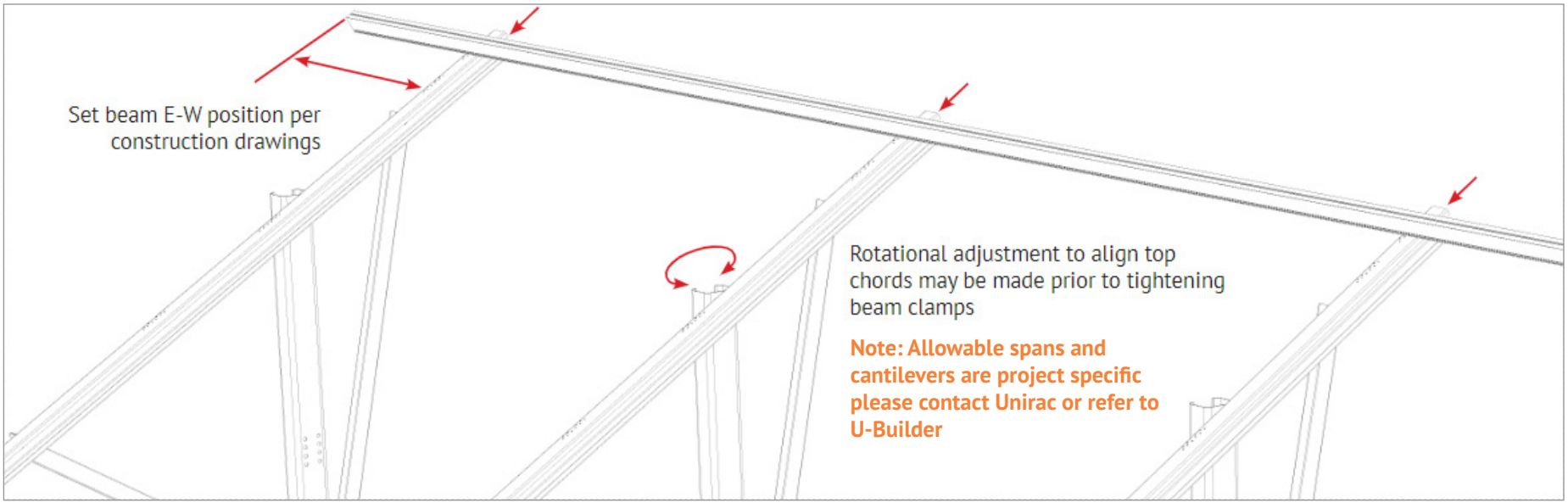


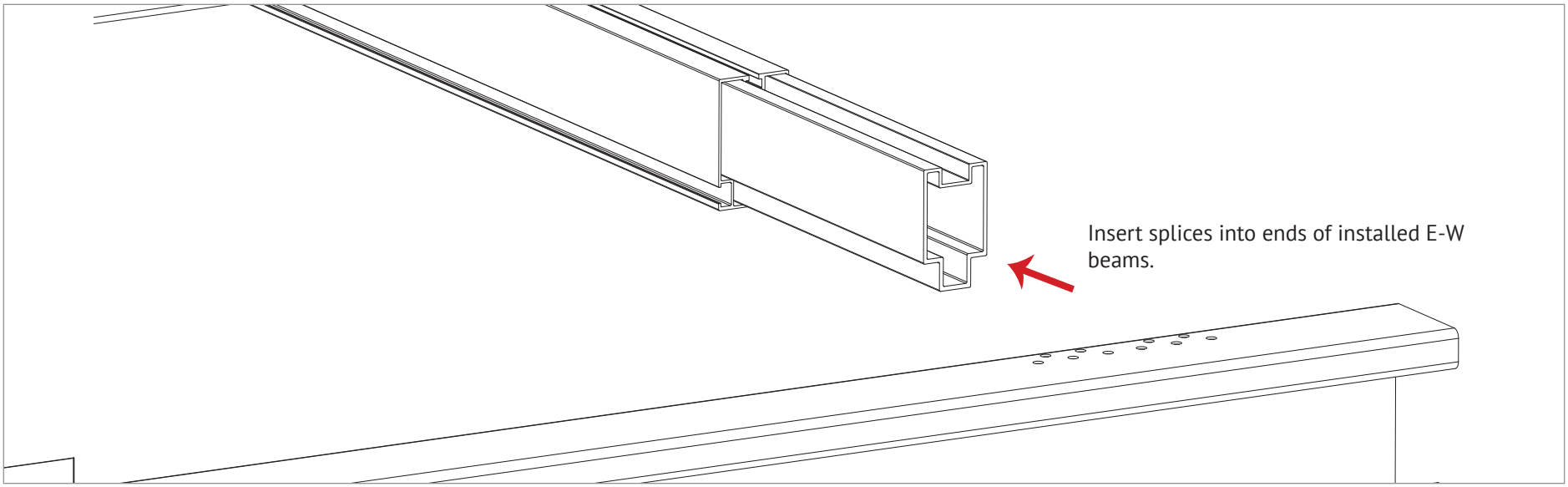

Install first set of top row E-W beams starting at either end of table

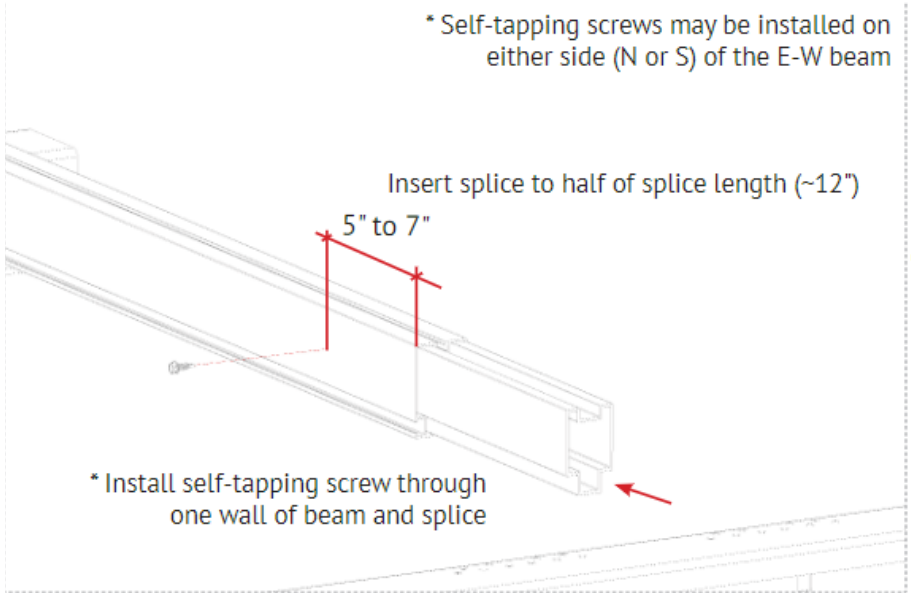
ATTACH E-W BEAMS TO TOP CHORDS

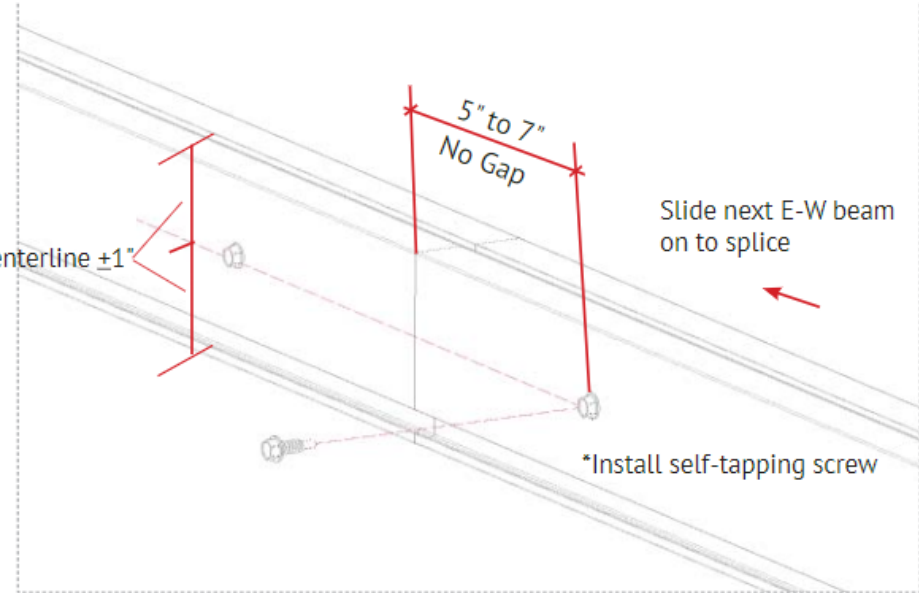


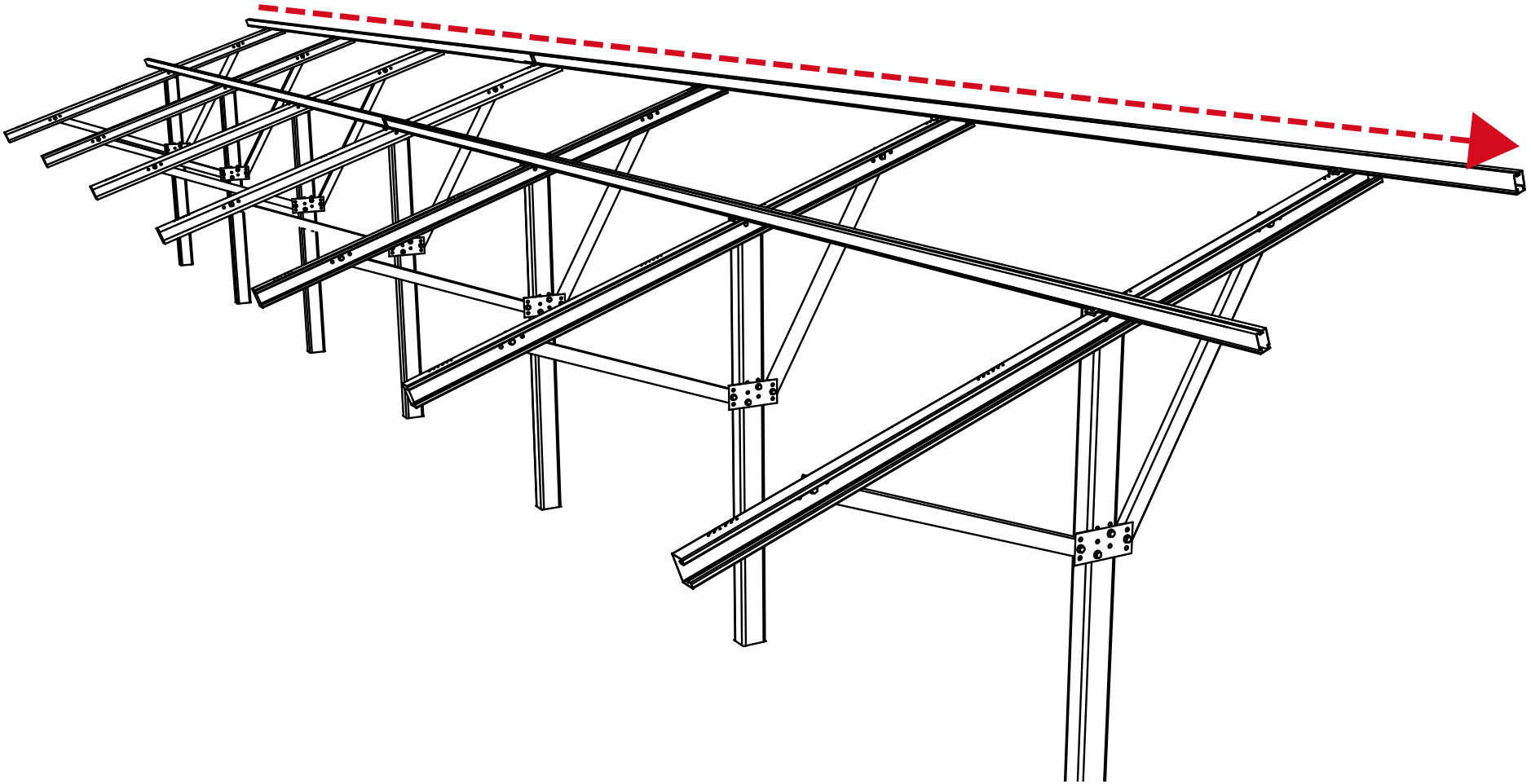




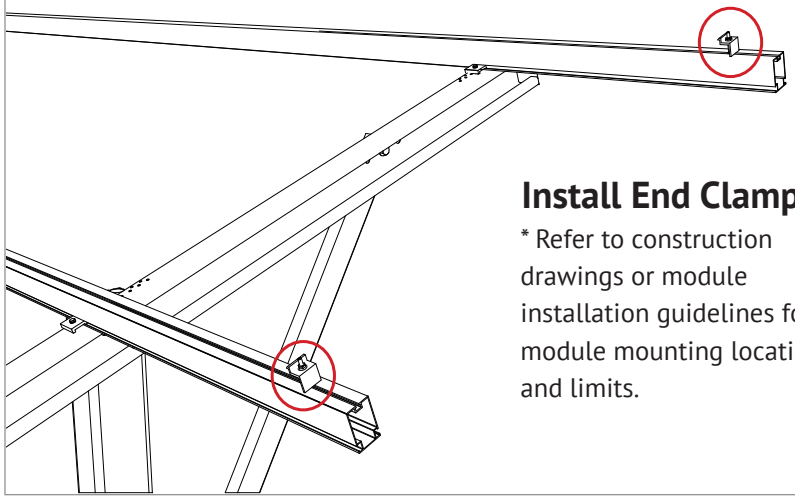

Insert splices into ends of installed E-W beams.


* Self-tapping screws may be installed on either side (N or S) of the E-W beam
Insert splice to half of splice length (~12")
5" to 7"
* Install self-tapping screw through one wall of beam and splice


5" to 7"
No Gap
Centerline ±1"
Slide next E-W beam on to splice
*Install self-tapping screw

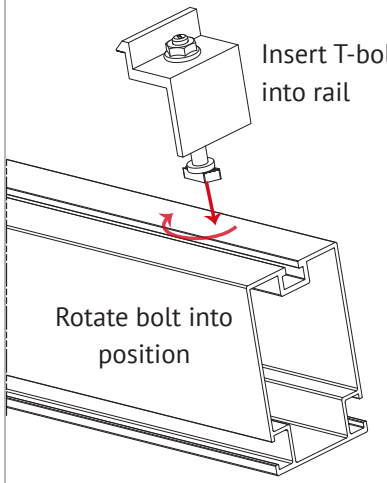


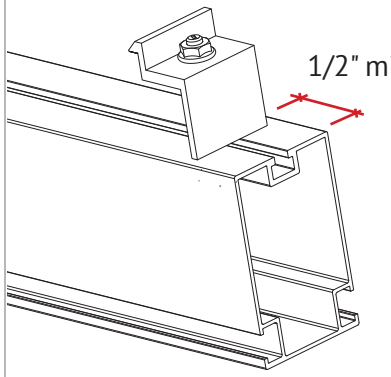
INSTALL MODULE W/STANDARD CLAMPS

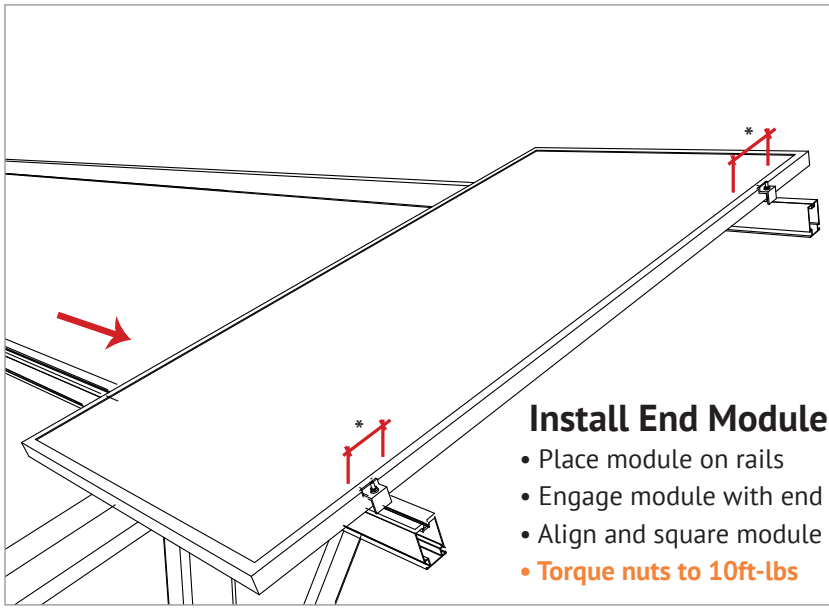


Install End Clamps

* Refer to construction drawings or module installation guidelines for module mounting locations and limits.



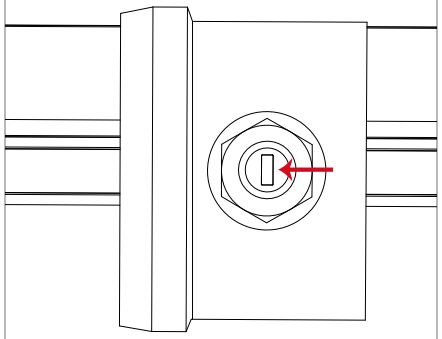




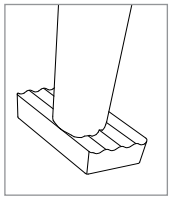
Install End Module

- Place module on rails
- Engage module with end clamps
- Align and square module
- **Torque nuts to 10ft-lbs**

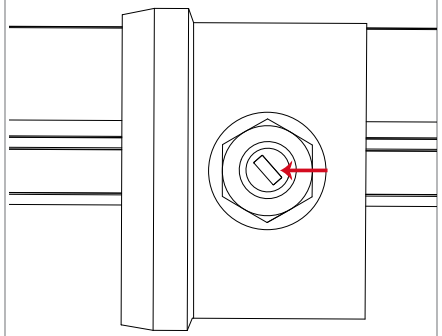
Serrated T- Bolts



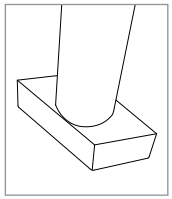
Verify that bolt position indicator is perpendicular to E-W beam



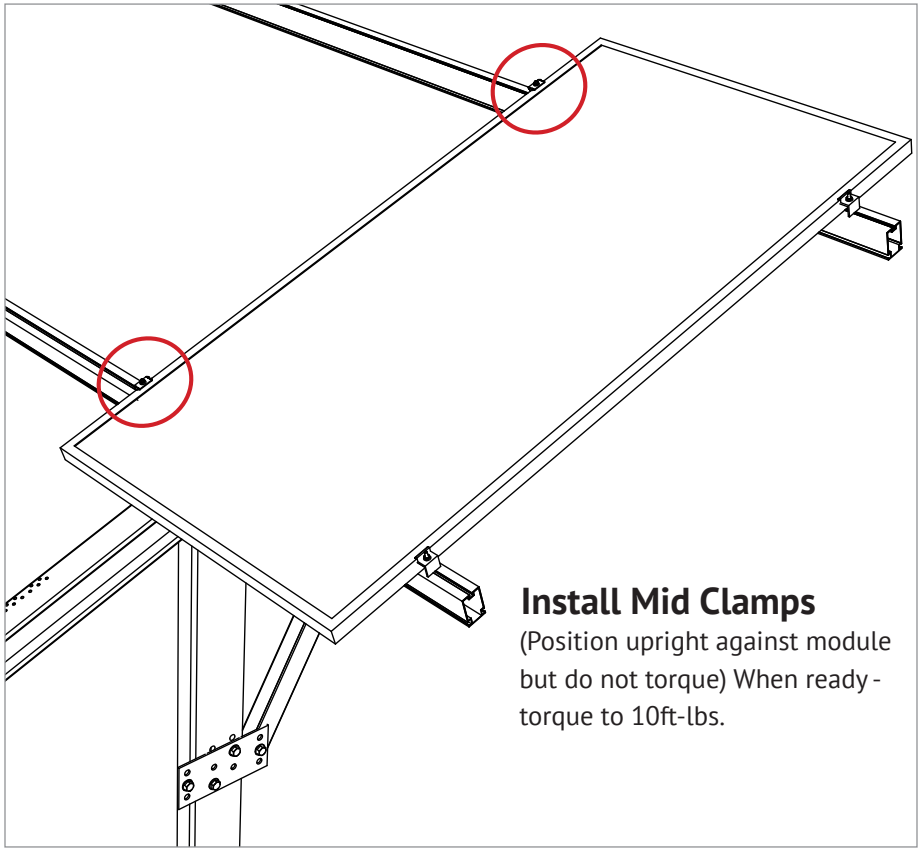
Non-Serrated T- Bolts



Verify that bolt position indicator is as shown

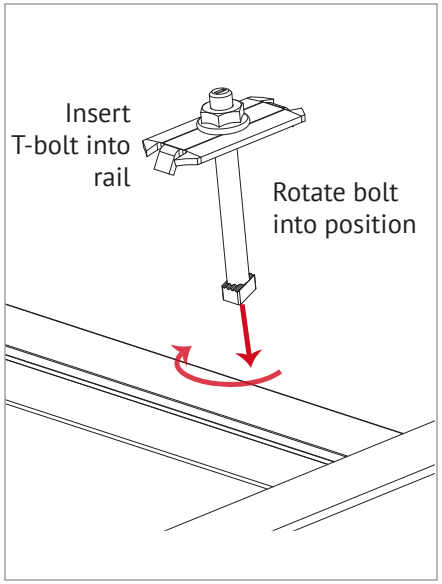


NOTE: *See appendix for different clamp configurations.

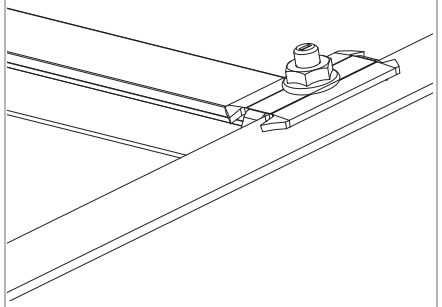


Install Mid Clamps
(Position upright against module but do not torque) When ready - torque to 10ft-lbs.

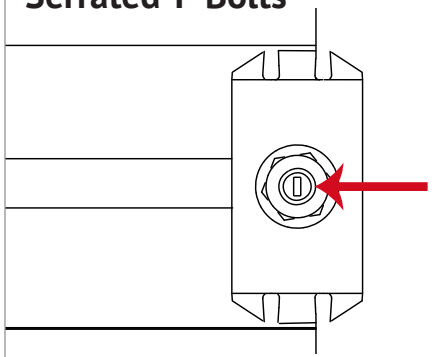
NOTE: *See appendix for different clamp configurations.



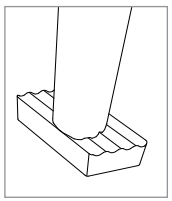
Position clamp on module.
Do not tighten nut until next module is in place.



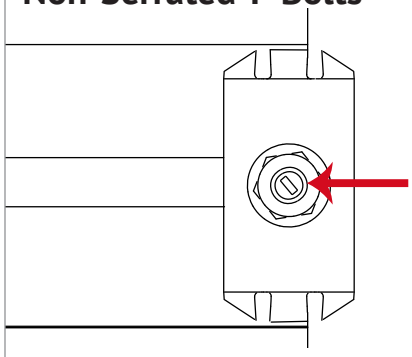
Serrated T- Bolts



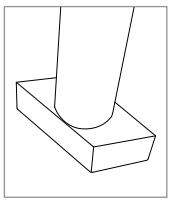
Verify that bolt position indicator is perpendicular to E-W beam

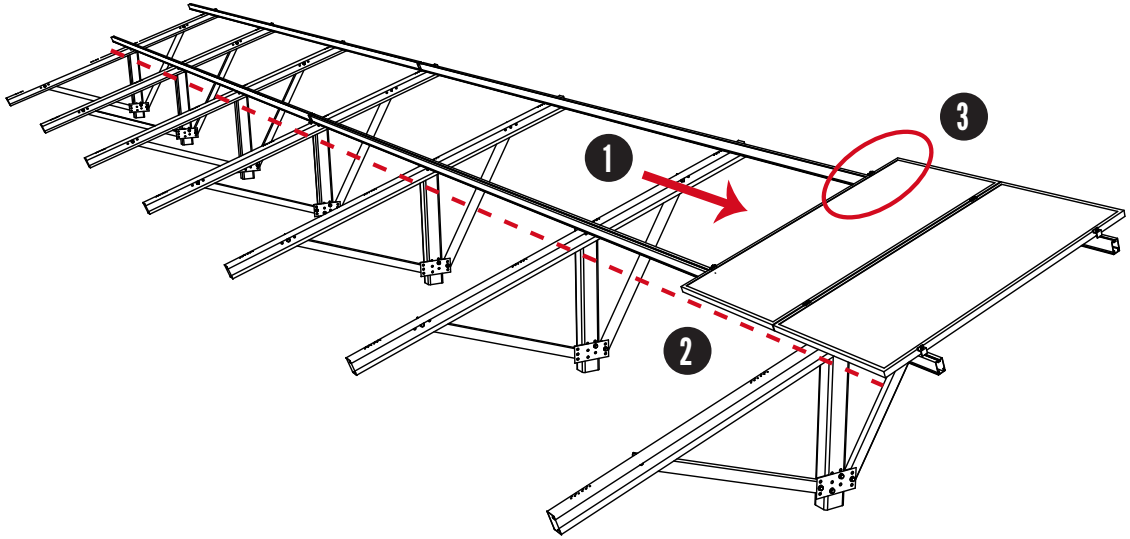


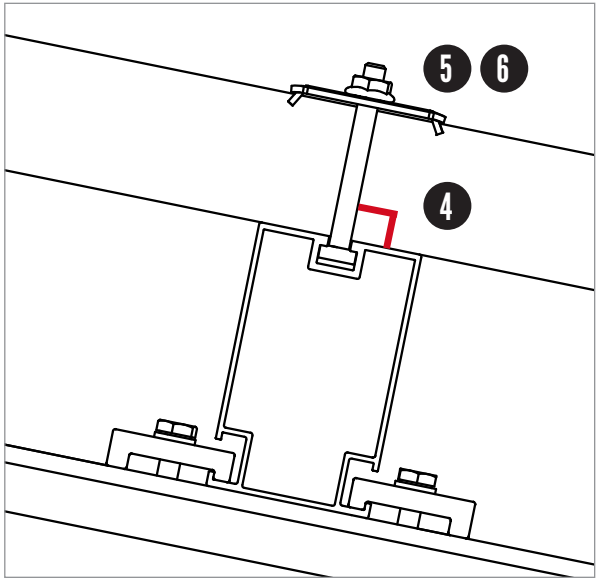
Non-Serrated T- Bolts

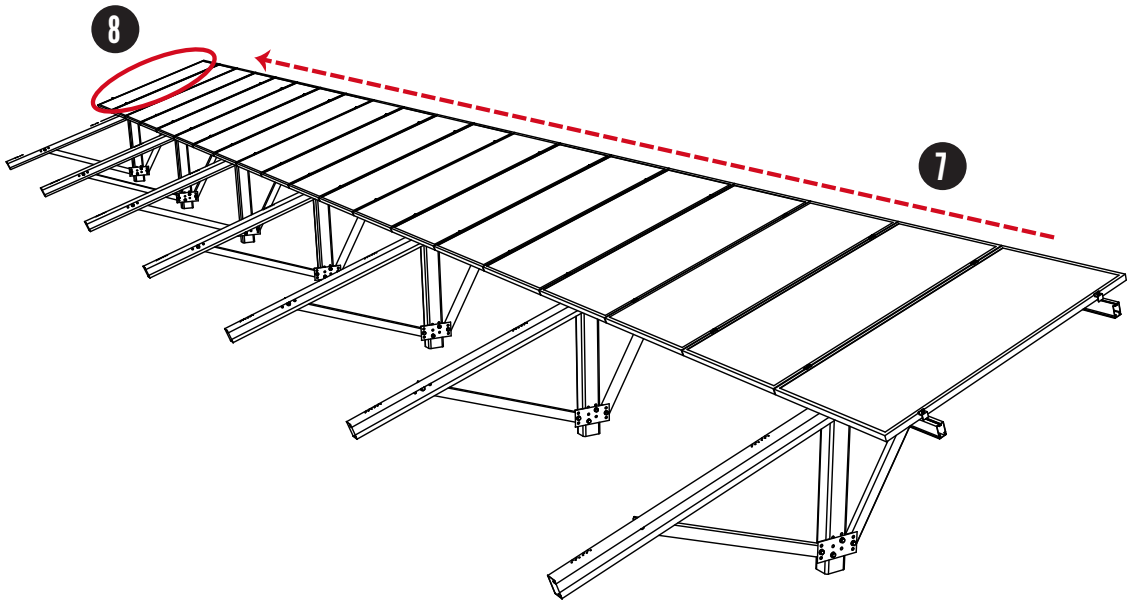


Verify that bolt position indicator is as shown



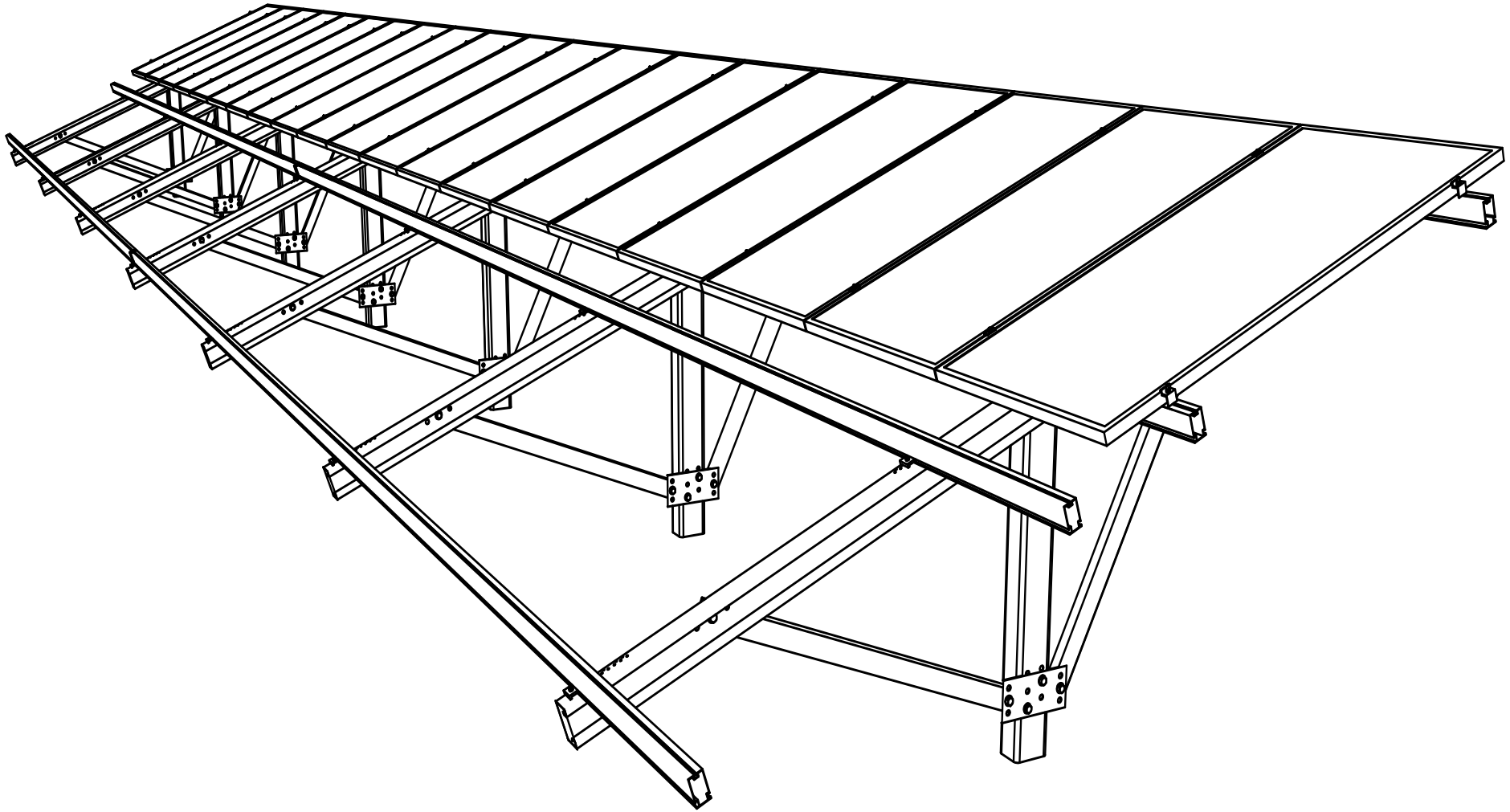


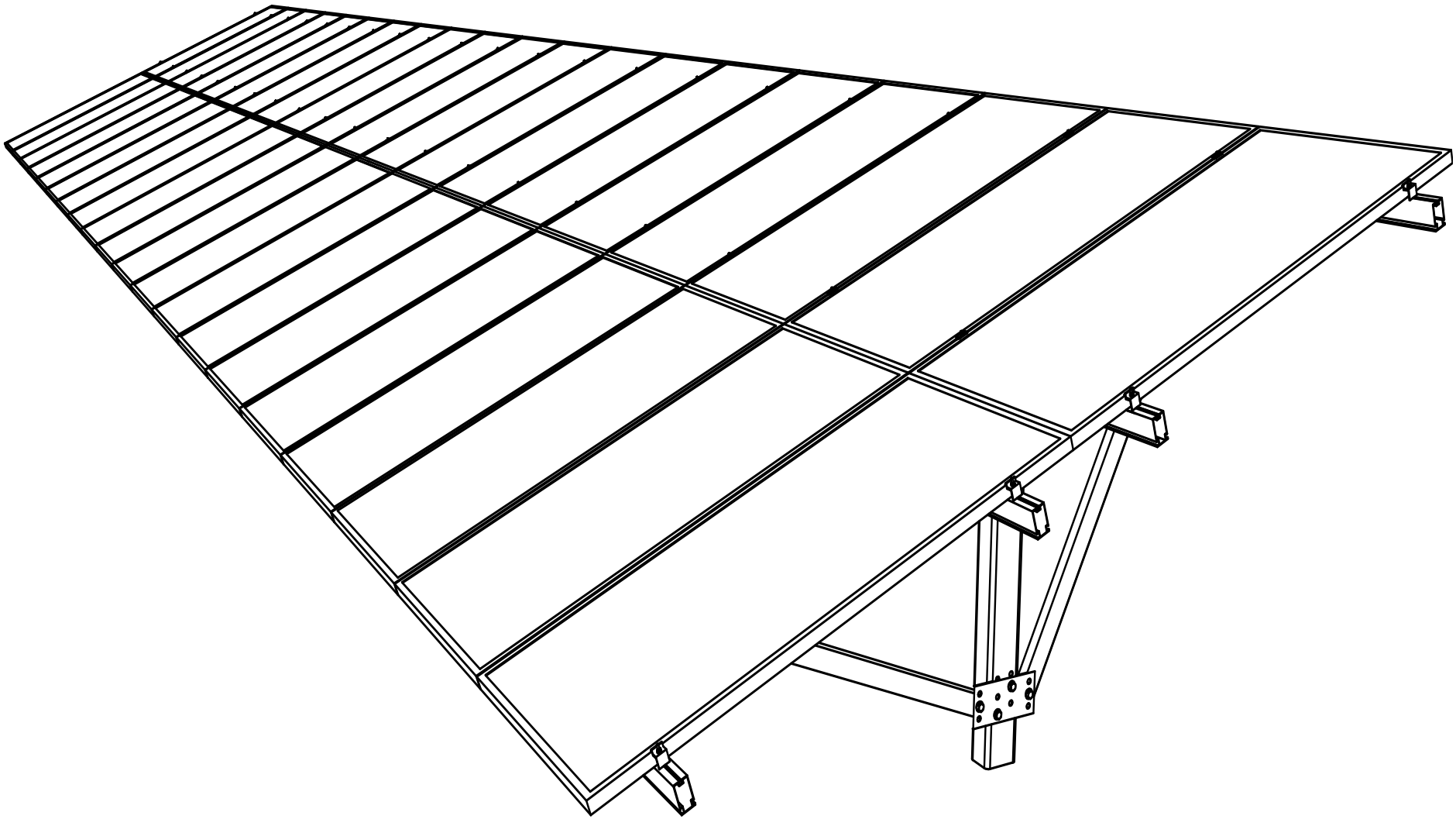


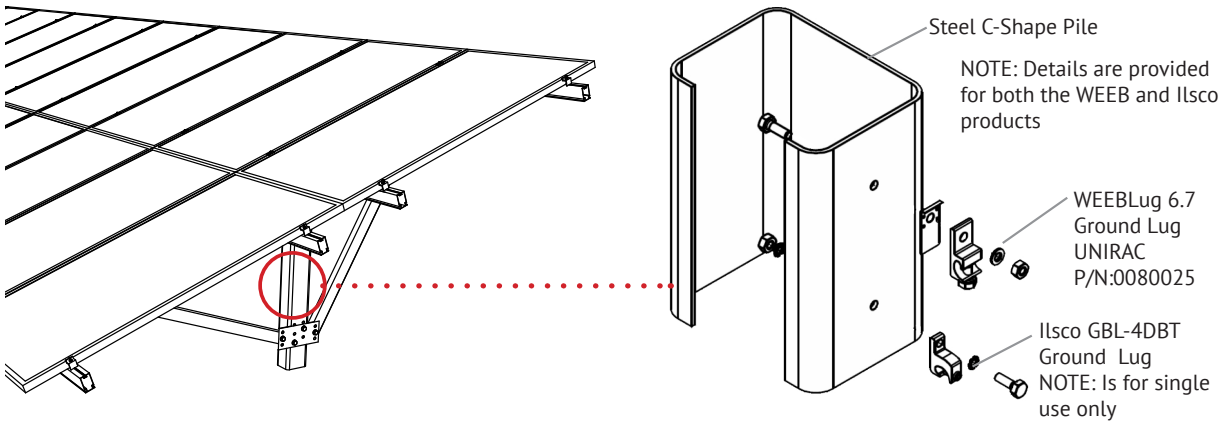


1. Place module on rails and engage with Mid Clamps
2. Align and square modules
3. Verify module gap (1/4")
4. Verify Mid Clamp bolt shafts are perpendicular to rail
5. Verify position of indicator mark on bolt
6. **Torque nuts to 10 ft-lbs**
7. Repeat installation of clamps and modules to complete top row
8. Install End Clamps on last module

NOTE: The GFT system must be periodically re-inspected for loose components, loose fasteners and any corrosion, such that if found, the affected components are to be immediately replaced.







The following grounding & bonding components have been certified to be compatible with Unirac GFT:

- Wiley WEEBLug (P/N 0080025) Torque 1/4" mounting hardware to 10ft-lbs. See product data sheet for conductor size and conductor fastener torque.
- Ilsco Lay-in Lug (P/N GBL-4DBT) Torque 10-32 mounting hardware to 5ft-lbs. See product data sheet for conductor size and conductor fastener torque.

Ground Lug	Bolt size	Drill size
WEEBLug	1/4"-20	17/64"
Ilsco	#10-32	7/31"

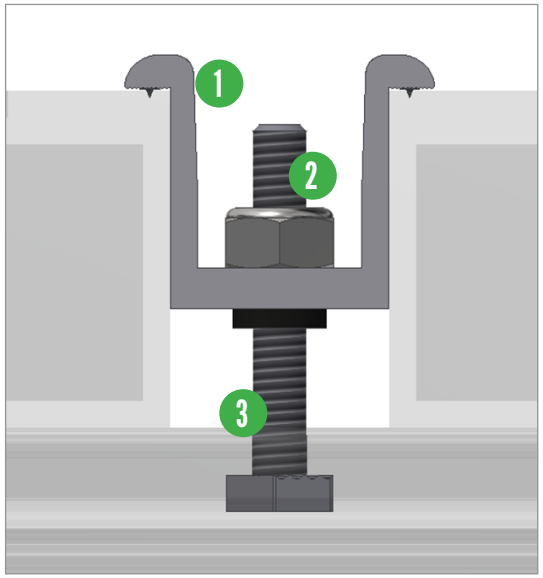
The entire Unirac GFT table has been classified for grounding & bonding to UL2703. The bonding path has been evaluated from the PV module frame all the way through to the pile. The following are suggestions to aid in grounding of the table for the project electrical engineer of record, and by the local authority having jurisdiction. This racking system may be used to ground and/or mount a PV module complying with UL1703 only when the specific module has been evaluated for grounding and/or mounting in compliance with the included instructions.

GROUND LUG MOUNTING DETAILS

Details are provided for both the WEEB and Ilsco products. The WEEB Lug has a grounding symbol located on the lug assembly. The Ilsco lug has a green colored set screw for grounding indication purposes. One lug is recommended per GFT table. Installation must be in accordance with NFPA NEC70, however the electrical designer of record should refer to the latest revision of National Electrical Code (NEC) for actual grounding conductor cable size. Unirac GFT is intended to be used with PV modules that have a system voltage less than or equal to that allowable by NEC. A minimum 10AWG, 105°C copper grounding conductor should be used to ground the system according to the (NEC) and the authority having jurisdiction. It is the installer responsibility to check local codes, which may vary.

NOTE:

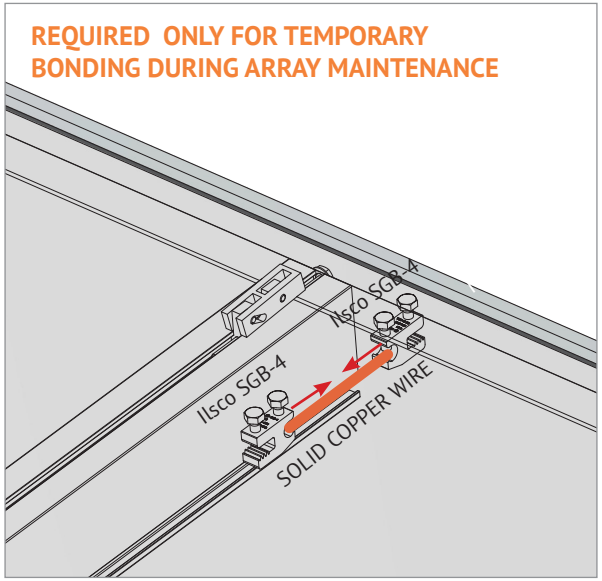
- **Any holes drilled to attach the ground lugs should be de-burred before use.**
- **All Unirac module clamps and the Ilsco GBL-4DBT ground lug are single use. All other GFT components are multiple use.**
- **Isolate copper from aluminum contact to prevent corrosion.**



BONDING MIDCLAMP ASSEMBLY

1. Aluminum mid clamp with stainless steel bonding pins that pierce module frame anodization to bond module to module through clamp
2. Stainless steel nut bonds aluminum clamp to stainless steel T-bolt
3. Serrated T-bolt head penetrates rail anodization to bond T-bolt, nut, clamp, and modules to SM rail

NOTE: All Unirac mid clamps and the UAF end clamp shown in this install guide are bonding clamps



TEMPORARY BONDING CONNECTION DURING ARRAY MAINTENANCE

When removing modules for replacement or system maintenance, any module left in place that is secured with a bonding Midclamp will be properly grounded. If a module adjacent to the end module of a row is removed or if any other maintenance condition leaves a module without a bonding mid clamp, a temporary bonding connection must be installed as shown

- Attach Ilsco SGB4 to wall of GFT rail
- Attach Ilsco SGB4 to module frame
- Install solid #6 AWG copper wire jumper to Ilsco lugs

ELECTRICAL CONSIDERATIONS

GFT is intended to be used with PV modules that have a system voltage less than or equal to that allowable by NEC. For standard system grounding a minimum 10AWG, 105°C copper grounding conductor should be used to ground a system, according to the National Electric Code (NEC). It is the installer's responsibility to check local codes, which may vary. See below for interconnection information.

INTERCONNECTION INFORMATION

There is no size limit on how many GFT & PV modules can be mechanically interconnected for any given configuration, provided that the installation meets the requirements of applicable building and fire codes.

GROUNDING NOTES

The installation must be conducted in accordance with the National Electric Code (NEC) and the authority having jurisdiction. Please refer to these resources in your location for required grounding lug quantities specific to your project.

The grounding / bonding components may overhang parts of the array so care must be made when walking around the array to avoid damage.

Conductor fastener torque values depend on conductor size. See product data sheets for correct torque values.

Mid clamps do not need to be repositioned for reuse.

Electrical Bonding and Grounding Test Modules

The list below is not exhaustive of compliant modules but shows those that have been evaluated and found to be electrically compatible with the GROUND FIXED TILT system.

Manufacture	Module Model / Series
Aionrise	AION60G1, AION72G1
Aleo	P-Series & S-Series
Aptos Solar	DNA-108-(MF/BF)10-xxxW DNA-120-(MF/BF)10-xxxW DNA-120-MF10, DNA-120-(MF/BF)23 DNA-144-(MF/BF)23, DNA-120-(MF/BF)26 DNA-144-(MF/BF)26
Astronergy	CHSM6612 M, M/HV CHSM6612P Series CHSM6612P/HV Series CHSM72M-HC CHSM72M(DG)/F-BH
Auxin	AXN6M610T AXN6P610T AXN6M612T AXN6P612T
Axitec	AC-xxx(M/P)/60S, AC-xxx(M/P)/72S AC-xxxP/156-60S AC-xxxMH/120(S/V/SB/VB) AC-xxxMH/144(S/V/SB/VB)
Bluesun Solar	HEX5 BSMxxxM10-54HPH BSMxxxM10-72HBD
Boviet Solar	BVM6610, BVM6612 BVM6612M-XXXS-H-HC-BF-DG BVM7612M-H-HC-BF-DG
BYD	P6K & MHK-36 Series
Canadian Solar	CS1(H/K/U/Y)-MS CS3K-(MB/MB-AG/MS/P/P HE/PB-AG) CS3L-(MS/P), CS3N-MS

Manufacture	Module Model / Series
Canadian Solar (Cont.)	CS3U-(MB/MB-AG/MS/P/P HE/PB/PB-AG) CS6.1-54TM-H CS6.1-60TM-H CS6.1-72TB-H CS3W-(MB-AG/MS/P/P-PB-AG) CS3Y-MB-AG, CS5A-M CS6K-(M/MS/MS AllBlack/P/P HE) CS6P-(M/P) CS6R-MS CS6R-xxxMS-HL CS6U-(M/P/P HE) CS6W-(MS/MB-AG) CS6X-P CSX-P ELPS CS6(A/P)-MM
Centrosolar America	C-Series & E-Series
CertainTeed	CT2xxMxx-01, CT2xxPxx-01, CTxxxMxx-01 CTxxxPxx-01, CTxxxMxx-02, CTxxxMxx-03 CTxxxMxx-04, CTxxxHC11-04 CTM10400HC11-08, CTM10400HC11-09
Eco Solargy	Orion 1000 & Apollo 1000
EMMVEE	ExxxP72-B, ExxxM72-B, ExxxH CM120-B
ET Solar	ET AC Module, ET Module ET-M772BH520-550WW/WB
First Solar	FS-6XXX(A) FS-6XXX(A)-P, FS-6XXX(A)-P-I
Flextronics	FXS-xxxBB
Freedom Forever	FF-MP-BBB-xxx, FF-MP1-BBB-xxx
FreeVolt	PVGraf

Manufacture	Module Model / Series
GCL	GCL-P6 & GCL-M6 Series
Hansol	TD-AN3, TD-AN4 UB-AN1, UD-AN1
Hanwha SolarOne	HSL 60
Heliene	36M, 36P 60M, 60P, 72M & 72P Series 144HC M6, 144HC M10 SL Bifacial
HT-SAAE	HT60-156M-C HT60-156M(V)-C HT72-156(M/P) HT72-156P-C, HT72-156P(V)-C HT72-156M(PDV)-BF, HT72-156M(PD)-BF HT72-166M HT72-18X
Hyperion Solar	HY-DH108P8(B), HY-DH108N8B HY-DH144P8 HY-DH156N8 HY-DH156P8
Hyundai	KG, MG, RW, TG, RI, RG, TI, KI, HI Series HiA-SxxxHG, HiD-SxxxRG(BK), HiS-S400PI HiS-SxxxYH(BK), HiS-SxxxXG(BK) HiN-SxxxXG(BK)
Imperial Star	ISM7-SHDD108-400/M
Inxeption	mSolar 108BB HC Series (TXI10-xxx108BB) mSolar 144BB HC Series (TXS6-xxx144BB)
ITEK	iT-SE Series
Japan Solar	JPS-60 & JPS-72 Series

The modules selected for UL 2703 bonding and grounding testing represent the broadest possible range of modules on the market. The tests were performed for each specific bonding location using representative module frame profile sections. The tests performed cover the following basic module parameters:

- The frame profile must not have any feature that might interfere with the bonding devices that are integrated into the racking system
- Use with a maximum over current protection device OCPD of 30A
- Unless otherwise noted, all modules listed above include all wattages and specific models within that series. Variable wattages are represented as "xxx"
- Items in parenthesis are those that may or may not be present in a compatible module's model ID
- Slashes "/" between one or more items indicates that either of those items may be the one that is present in a module's model ID

Electrical Bonding and Grounding Test Modules

The list below is not exhaustive of compliant modules but shows those that have been evaluated and found to be electrically compatible with the GROUND FIXED TILT system.

Manufacture	Module Model / Series
JA Solar	JAM54S30 xxx/MR JAM54S31 xxx/MR JAM72D30 xxx/MB, JAM78D10 xxx/MB JAM72S30 /MR JAP6 60-xxx JAM6(K)-60/xxx, JAP6(k)-72-xxx/4BB JAP72S##-xxx/** JAP6(k)-60-xxx/4BB, JAP60S##-xxx/** JAM6(k)-72-xxx/**, JAM72S##-xxx/** JAM6(k)-60-xxx/**, JAM60S##-xxx/** i. ##: 01, 02, 03, 09, 10 ii. **: SC, PR, BP, HiT, IB, MW, MR ** = Backsheet, ## Cell technology
Jinko	JKM & JKMS Series JKMxxxM-72HL-V, JKMxxxM-72HL4-(T)V JKMxxxM-72HLM-TV, JKMxxxM-7RL3-V JKMxxxM-72HBL-V, JKMxxxM-72HL4-TV JKMxxxM-6RL3-B, JKMxxxN-72HL4-BDV JKMxxxN-54HL4-B, JKMxxxN-72HL4-TV JKMxxxM-7RL3-TV
Kyocera	KD-F & KU Series
LA Solar	LSxxxHC(166), LSxxxBF, LSxxxBL, LSxxxHC, BLA Model
LG Electronics	LGxxx(E1C/E1K/N1C/N1K/N2T/N2W/S1C/S2W/Q1C/Q1K)-A5 LGxxx(A1C/M1C/M1K/N1C/N1K/Q1C/Q1K/QAC/QAK)-A6, LGxxxN2W-B3, LGxxxN2T-B5 LGxxxN1K-B6, LGxxx(N1C/N1K/N2T/N2W)-E6 LGxxx(N1C/N1K/N2W/S1C/S2W)-G4

Manufacture	Module Model / Series
LG Electronics (Cont.)	LGxxxN2T-J5 LGxxx(N1K/N1W/N2T/N2W)-L5 LGxxx(M1C/N1C/Q1C/Q1K)-N5 LGxxx(N1C/N1K/N2W/Q1C/Q1K)-V5 LGxxxN3K-V6
LONGi	LR4-60(HPB/HPH) LR4-72(HBD/HPH) LR6-60 LR6-60(BK/HPB/HPH/HV/PB/PE/PH) LR6-72 LR6-72(BK/HBD/HV/PB/PE/PH) RealBlack LR4-60HPB RealBlack LR6-60HPB LR5-54-HPB-xxxM LR5-72HBD xxxM
Maxeon	SPR-MAX3-xxx-COM SPR-MAX3-XXX-R SPR-MAX3-XXX-BLK-R
Meyer Burger	Meyer Burger Black, Meyer Burger White Meyer Burger Glass
Mission Solar Energy	MSExxxSX9R MSE Mono, MSE Perc MSExxx(SR8T/SR8K/SR9S/SX5T) MSExxx(SX5K/SX6W) MSExxxHT0B
Mitrex	Mxxx-L3H, Mxxx-I3H
Mitsubishi	MJE & MLE Series
mSolar	TXI10-xxx108BB
Neo Solar Power Co.	D6M Series

Manufacture	Module Model / Series
NE Solar	NESE xxx-72MHB-M10 NESE xxx-60MH-M6 NESE XXX 72MHT-M10 NESE XXX 72THB-M10 NESE XXX 72MHB-M10
Panasonic	VBHNxxxSA06/SA06B/SA11/SA11B VBHNxxxSA15/SA15B/SA16/SA16B, VBHNxxxKA, VBHNxxxKA03/04, VBHNxxxSA17/SA17G/SA17E/SA18/SA18E, VBHNxxxZA01/ZA02/ZA03/VBHNxxxZA04, EVPVxxx, EVPVxxx(H/K/PK/HK/HK2)
Peimar	SGxxxM (FB/BF), SMxxxM
Philadelphia Solar	PS-M108(HCBF)-400W (30 & 35mm frames)
Phono Solar	PSxxxM1-20/U, PSxxxM1H-20/U PSxxxM1-20UH, PSxxxM1H-20UH PSxxxM1-20/UH, PSxxxM1H-20/UH PSxxxM-24/T, PSxxxMH-24/T PSxxxM-24/TH, PSxxxMH-24/TH PSxxxM4(H)-24/TH
Prism Solar	P72 Series, P72X-xxx
Q Cells	Plus, Pro, Peak, G3, G4, Peak G5(SC) , G6(+)(SC)(AC), G7, G8(+) Plus, Pro, Peak L-G2, L-G4, L-G5 Peak L-G5, L-G6, L-G7, L-G8(BFF) Q.PEAK DUO(BLK)-G6+ Q.PEAK DUO BLK-G6+/TS Q.PEAK DUO (BLK)-G7 Q.PEAK DUO L-(G7/G7.1/G7.2/G7.3/G7.7) Q.PEAK DUO (BLK) G8(+)

The modules selected for UL 2703 bonding and grounding testing represent the broadest possible range of modules on the market. The tests were performed for each specific bonding location using representative module frame profile sections. The tests performed cover the following basic module parameters:

- The frame profile must not have any feature that might interfere with the bonding devices that are integrated into the racking system
- Use with a maximum over current protection device OCPD of 30A
- Unless otherwise noted, all modules listed above include all wattages and specific models within that series. Variable wattages are represented as "xxx"
- Items in parenthesis are those that may or may not be present in a compatible module's model ID
- Slashes "/" between one or more items indicates that either of those items may be the one that is present in a module's model ID

Electrical Bonding and Grounding Test Modules

The list below is not exhaustive of compliant modules but shows those that have been evaluated and found to be electrically compatible with the GROUND FIXED TILT system.

Manufacture	Module Model / Series
Q Cells (cont.)	Q.PEAK DUO L-(G8/G8.1/G8.2/G8.3) Q.PEAK DUO L-G8.3 BFG/BGT Q.PEAK DUO (BLK) ML-G9(+) Q.PEAK DUO XL-(G9/G9.2/G9.3) Q.PEAK DUO XL-G9.3 BFG Q.PEAK DUO G10+ Q.PEAK DUO BLK G10(+) Q.PEAK DUO BLK G10+ /AC Q.PEAK DUO (BLK) ML-G10(a)(+) Q.PEAK DUO BLK ML-G10+ / t Q.PEAK DUO BLK ML-G10+ / TS Q.TRON M-G2+ SERIES Q.TRON BLK M-G2+ SERIES Q.PEAK DUO XL-G11S.3 / BFG Q.PEAK DUO XL-(G10/G10.2/G10.3/G10.c/ G10.d) Q.PEAK DUO XL-G10.3/BFG Q.PEAK DUO XL-G10.d/BFG Q.PEAK DUO XL-(G11.2/G11.3) Q.PEAK DUO XL-G11.3/BFG Q.TRON XL-G2.3/BFG
REC	RECxxxAA (BLK/Pure/Pure-R/ Pure-RX/ Pure 2/ Pro M) RECxxxNP (N-PEAK) RECxxxNP2 (Black) RECxxxNP3 Black RECxxxPE, RECxxxPE72 RECxxxTP, RECxxxTP72 RECxxxTP2(M/BLK2) RECxxxTP2S(M)72 RECxxxTP3M (Black) RECxxxTP4 (Black)

Manufacture	Module Model / Series
Renesola	All 60-cell modules
Risen	RSM Series, RSM110-8-xxxBMDG
SEG Solar	SEG-xxx-BMD-HV, SEG-xxx-BMD-TB SEG-XXX-BMB-TB, SEG-xxx-BMA-HV SEG-xxx-BMA-TB, SEG-xxx-BMB-HV SEG-xxx-BMA-BG, SEG-xxx-BMB-BG SEG-xxx-BTA-BG, SEG-xxx-BTB-BG SEG-xxx-BMD-BG, SEG-xxx-BTD-BG
S-Energy	SN72 & SN60 Series SL45-60BGI/BHI SL45-60MBI-xxxZ
Seraphim	SEG-(6PA/6PB/6MA/6MA-HV/6MB/E01/E11) SRP-(6QA/6QB) SRP-xxx-6MB-HV, SRP-320-375-BMB-HV, SRP-xxx-BMC-HV, SRP-390-450-BMA-HV, SRP-xxx-BMZ-HV, SRP-390-405-BMD-HV
Sharp	NU-SA & NU-SC Series
Silfab	SLA-M, SLA-P, SLG-M, SLG-P & BC Series SILxxx(BG/BK/BL/HC/HC+/HL/HM/HN/ML/ NL/NT/NX/NU/ QD/QM)
Sirius	ELNSM72M-HC Series ELNSM54M-HC Series
Solar4America	S4Axxx-108MH10BB, S4Axxx-72MH5BB S4Axxx-144MH10xxx, S4Axxx-144TH10xxx S4Axxx-144TH16xxx, S4Axxx-108MH10xxx S4Axxx-108TH10xxx
SolarEver USA	SE-166*83-xxxM-120N SE-182*91-xxxM-108N

Manufacture	Module Model / Series
Solaria	PowerXT-xxxR-(AC/PD/BD) PowerXT-xxxC-PD PowerXT-xxxR-PM (AC) PowerX-400R
Solartech	STU HJT, STU PERC & Quantum PERC
SolarWorld	Sunmodule Protect, Sunmodule Plus/Pro
Sonali	SS-M-360 to 390 Series SS-M-390 to 400 Series SS-M-440 to 460 Series SS-M-430 to 460 BiFacial Series
Sun Edison	F-Series, R-Series
Suniva	MV Series & Optimus Series (35mm)
Sunmac Solar	M754SH-BB Series
SunPower	AC, X-Series, E-Series & P-Series SPR E20 435 COM (G4 Frame) Axxx-BLK-G-AC, SPR-Mxxx-H-AC SPR-Mxxx-H-AC, SPR-Mxxx-BLK-H-AC
Suntech	STP, STPXXXS - B60/Wnhb
Talesun	TP572, TP596, TP654, TP660 TP672, Hipor M, Smart TD6I72M, TP7G54M(H) TD7G72M
Tesla	SC, SC B, SC B1, SC B2, TxxxS, TxxxH
Thornova	TS-BG54

The modules selected for UL 2703 bonding and grounding testing represent the broadest possible range of modules on the market. The tests were performed for each specific bonding location using representative module frame profile sections. The tests performed cover the following basic module parameters:

- The frame profile must not have any feature that might interfere with the bonding devices that are integrated into the racking system
- Use with a maximum over current protection device OCPD of 30A
- Unless otherwise noted, all modules listed above include all wattages and specific models within that series. Variable wattages are represented as "xxx"
- Items in parenthesis are those that may or may not be present in a compatible module's model ID
- Slashes "/" between one or more items indicates that either of those items may be the one that is present in a module's model ID

Electrical Bonding and Grounding Test Modules

The list below is not exhaustive of compliant modules but shows those that have been evaluated and found to be electrically compatible with the GROUND FIXED TILT system.

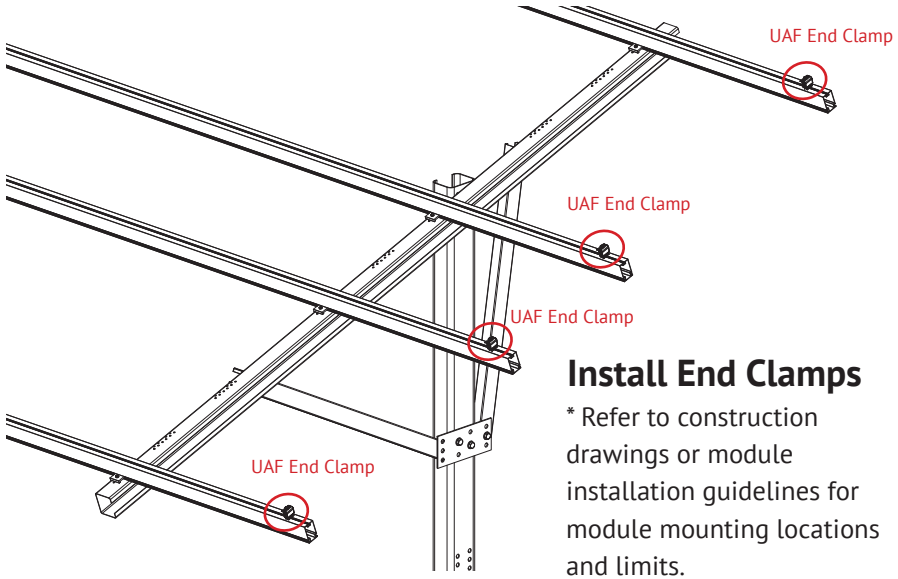
Manufacture	Module Model / Series
Trina	PA05, PD05, DD05, DD06, DE06, DE09.05, DE09C.07 PD14, PE14, DD14, DE14, DE15, DE15V(II) DEG15HC.20(II), DEG15MC.20(II) DEG15VC.20(II), DE18M(II), DEG18MC.20(II) DE19, DEG19C.20 TSM-NE09RC.05 TSM-NEG19RC.20
TSMC	TS-150C2 CIGSw
Universal Solar	UNI4xx-144BMH-DG UNI5xx-144BMH-DG UNIxxx-108M-BB UNIxxx-120M-BB UNIxxx-120MH
Upsolar	UP-MxxxP, UP-MxxxM(-B)
URECO	D7Kxxx(H7A/H8A), D7Mxxx(H7A/H8A) FAKxxx(C8G/E8G), FAMxxxE7G-BB FAMxxxE8G(-BB), FBKxxxM8G F6MxxxE7G-BB FBMxxxMFG-BB
Vikram Solar	Eldora, Somera, Ultima PREXOS VSMDHT.60.AAA.05 PREXOS VSMDHT.72.AAA.05 Paradea VSMDH.72.AAA.05
Vina	VNS-72M1-5-xxxW-1.5 VNS-72M3-5-xxxW-1.5 VNS-144M1-5-xxxW-1.5 VNS-144M3-5-xxxW-1.5 VNS-120M3-5-xxxW-1.0

Manufacture	Module Model / Series
VSUN	VSUNxxx-60M-BB, VSUNxxx-72MH VSUN4xx-144BMH VSUN4xx-144BMH-DG VSUN5xx-144BMH-DG VSUNxxx-108M-BB VSUNxxx-120M-BB VSUNxxx-120BMH VSUNxxx-132BMH VSUNxxx-108BMH VSUNxxxN-144BMH VSUNxxxN-144MH VSUNxxx-144BMH VSUNxxx-144MH VSUNxxx-144M-BW VSUNxxx-144M-BB
Waaree	Ahnay Series Bi-33 Arka Series WSMDi
Winaico	WST & WSP Series
Yingli	YGE & YLM Series
Yotta Energy	YSM-B450-1
ZNShine Solar	ZXM7-SHLDD144 ZXM7-SHDB144 ZXM6-72 Series ZXM6-NH144 ZXM6-NHLDD144 ZXM7-SH108 Series ZXM7-UHLDD144

The modules selected for UL 2703 bonding and grounding testing represent the broadest possible range of modules on the market. The tests were performed for each specific bonding location using representative module frame profile sections. The tests performed cover the following basic module parameters:

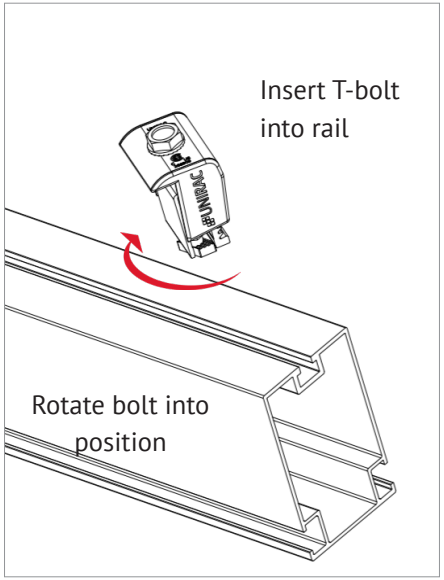
- The frame profile must not have any feature that might interfere with the bonding devices that are integrated into the racking system
- Use with a maximum over current protection device OCPD of 30A
- Unless otherwise noted, all modules listed above include all wattages and specific models within that series. Variable wattages are represented as "xxx"
- Items in parenthesis are those that may or may not be present in a compatible module's model ID
- Slashes "/" between one or more items indicates that either of those items may be the one that is present in a module's model ID

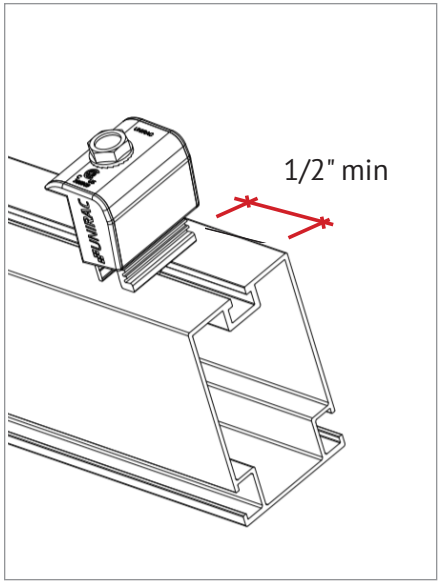
UNIVERSAL AF CLAMPS INSTALL MODULE W/END CLAMPS



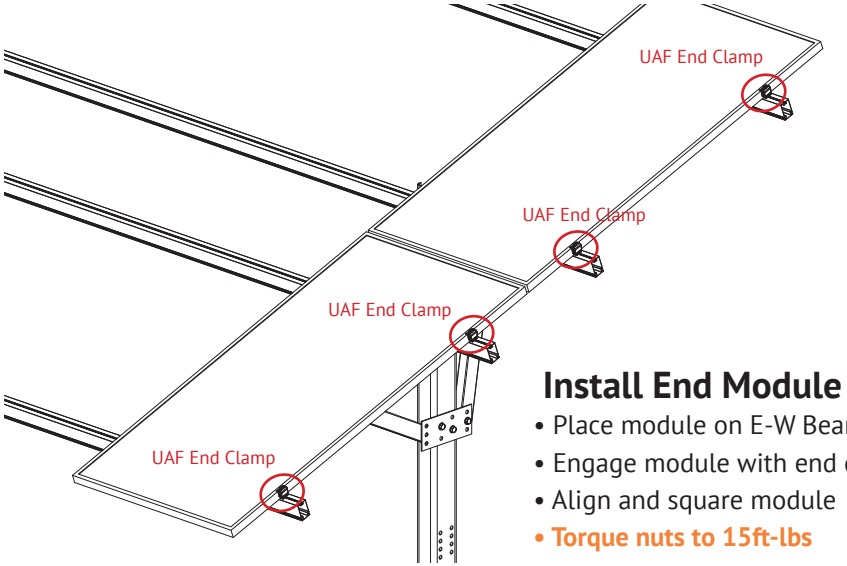
Install End Clamps

* Refer to construction drawings or module installation guidelines for module mounting locations and limits.





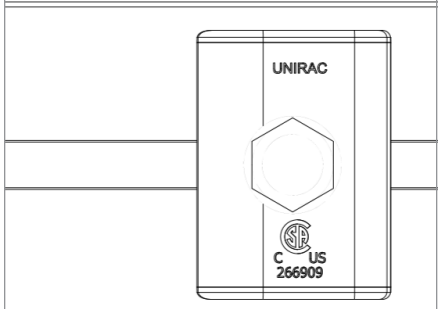
NOTE - Universal AF End Clamps are single use only



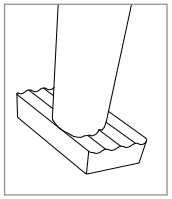
Install End Module

- Place module on E-W Beams
- Engage module with end clamps
- Align and square module
- **Torque nuts to 15ft-lbs**

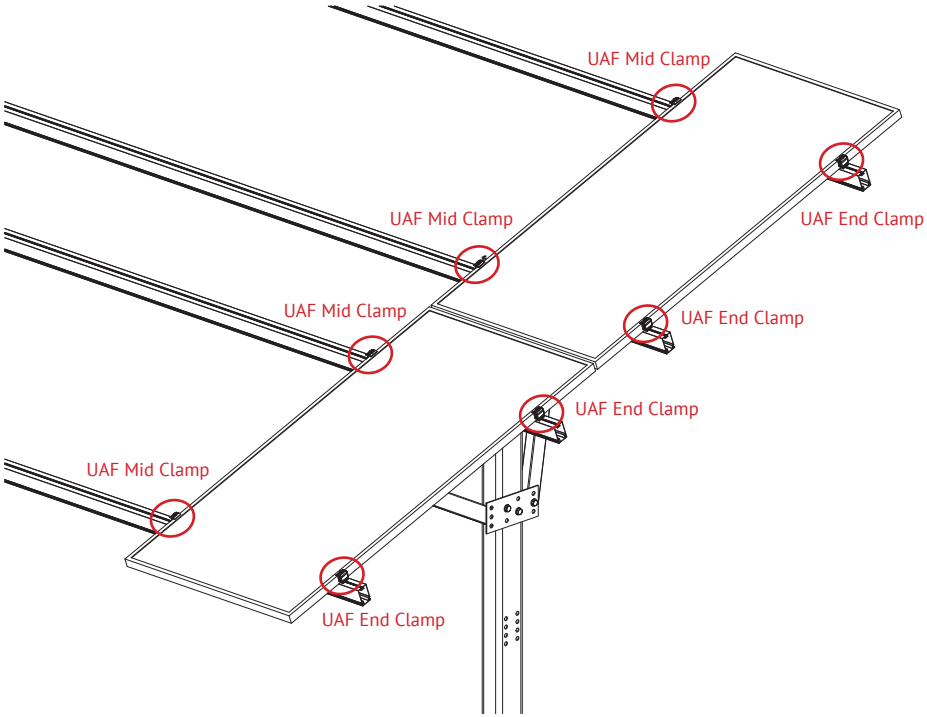
Serrated T- Bolts



Verify that bolt position indicator is perpendicular to E-W beam



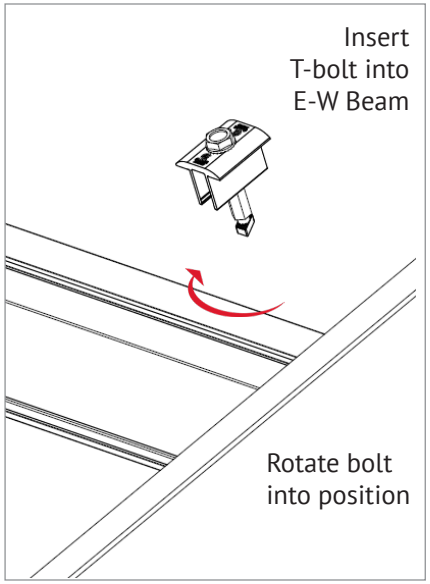
UNIVERSAL AF CLAMPS INSTALL MID CLAMPS ON 1ST MODULE

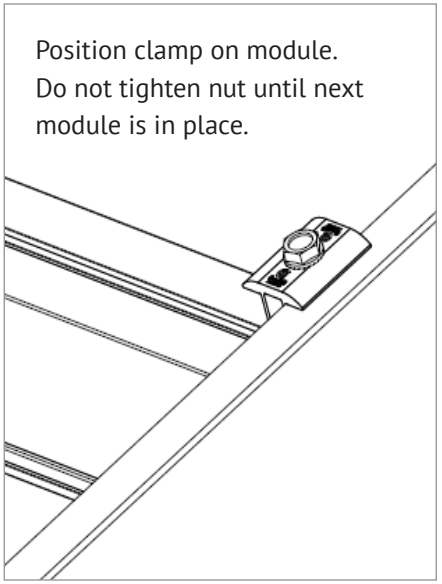


Install Mid Clamps

(Position upright against module but do not torque.) When ready - **torque to 15ft-lbs.**

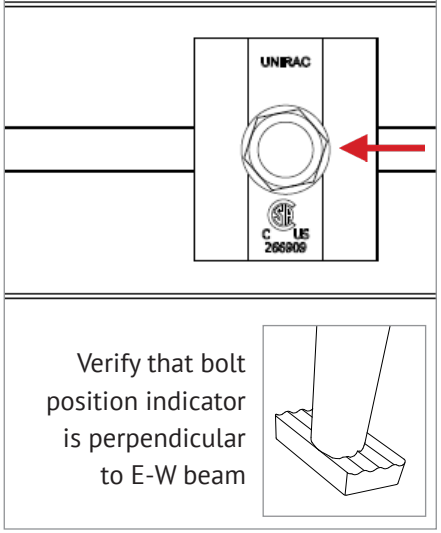
NOTE: Please refer to the GFT Shared rail install manual when using a shared rail.

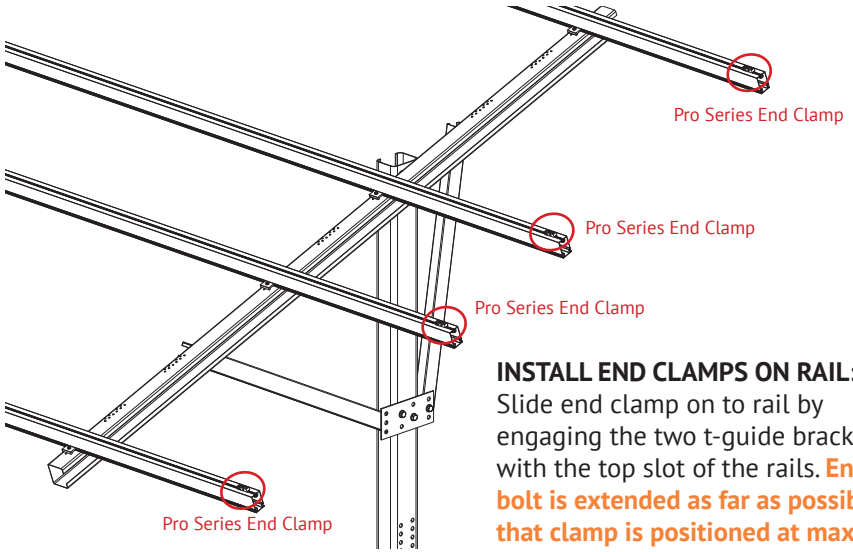




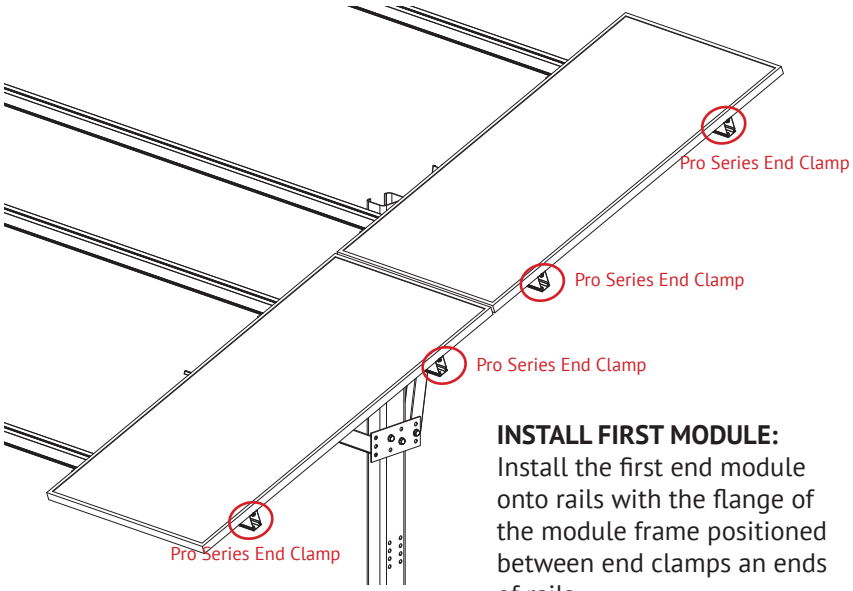
NOTE - Universal AF Mid Clamps are single use only

Serrated T- Bolts

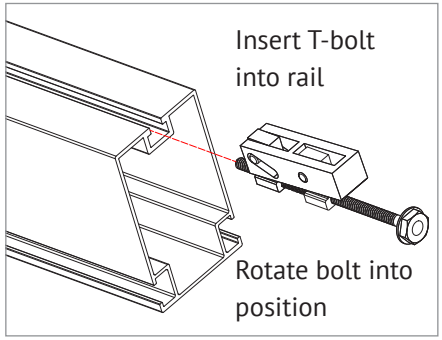




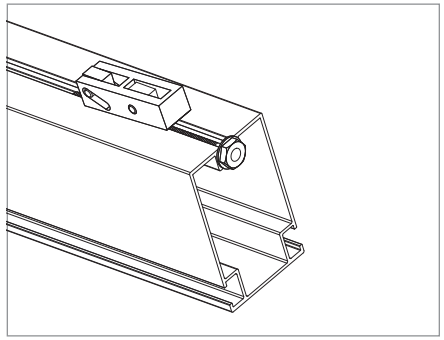
INSTALL END CLAMPS ON RAIL:
Slide end clamp on to rail by engaging the two t-guide brackets with the top slot of the rails. **Ensure bolt is extended as far as possible so that clamp is positioned at max. distance from end of rail.**



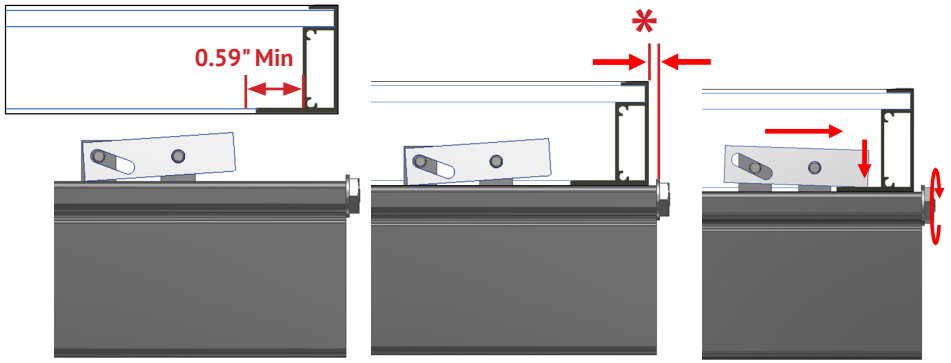
INSTALL FIRST MODULE:
Install the first end module onto rails with the flange of the module frame positioned between end clamps an ends of rails.



POSITION END CLAMPS:
Slide end clamp assembly on to rail until bolt head engages with end of rail. End clamps are positioned on rails prior to the first end module and prior to the last end module.



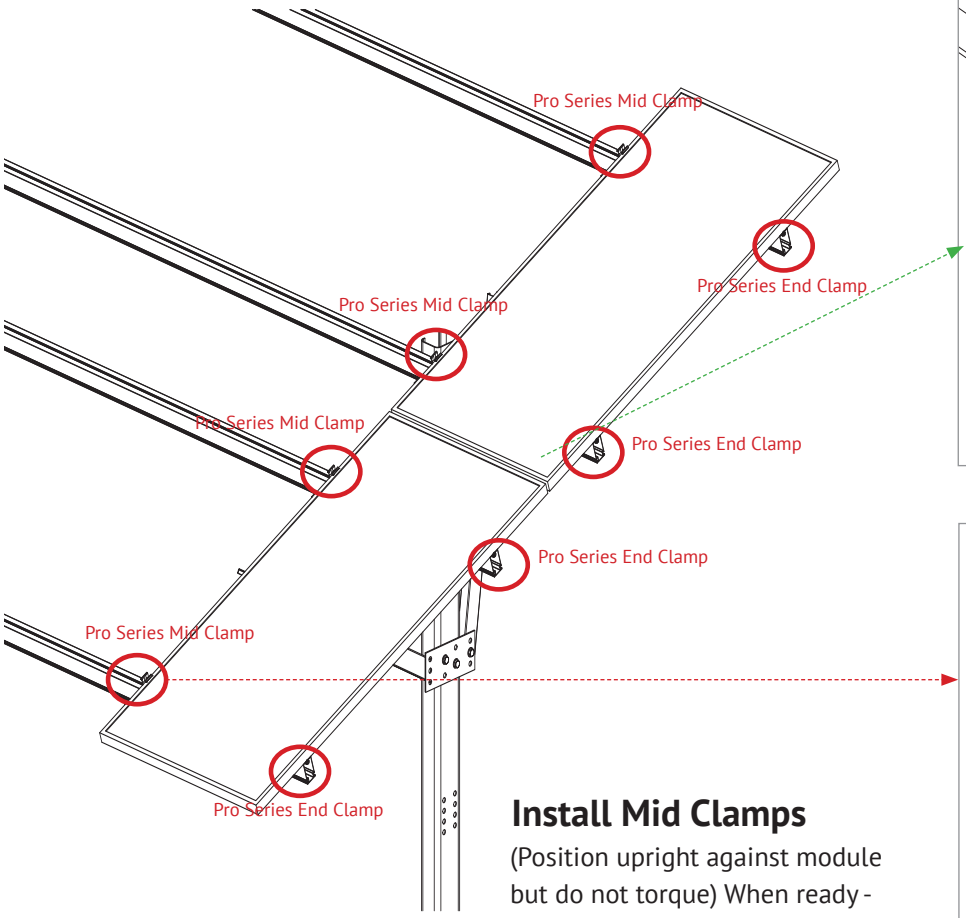
NOTE - To assist insertion of clamp into rail slot, Pressure may be applied to top or side of bracket as shown. Do not force clamp into rail by pushing on bolt with excessive force.



ENGAGE CLAMP:
While holding module in position and with flange in full contact with rail, rotate end clamp bolt until clamp engages with flange to provide clamp force. **To ensure bolt is not over-torqued, use low torque setting on drill or If using an impact driver, stop rotation as soon as impact action of driver begins. Torque End clamp bolt to 5 ft-lbs, No anti-seize**

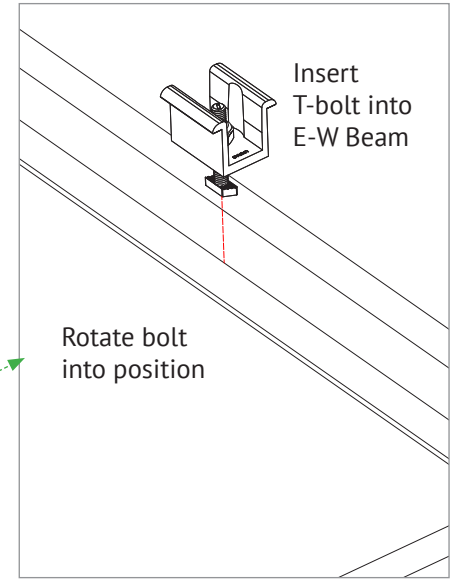
NOTE:
Requires minimum return flange length of 0.59" for Pro Series Hidden Endclamp to secure module

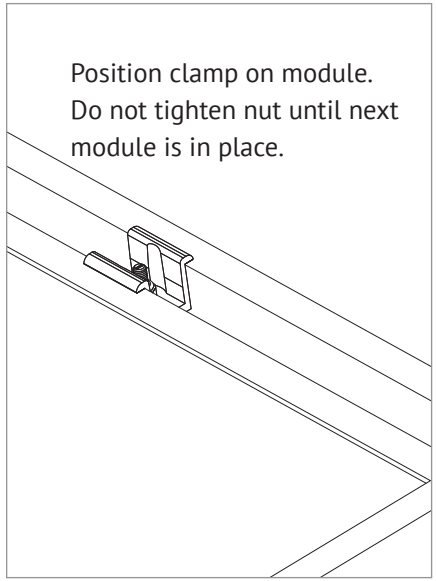
* Position module flush with ends of rails. Rails should not extend more than 1/2" beyond module. Module must be fully supported by rails and cannot overhang ends of rails.



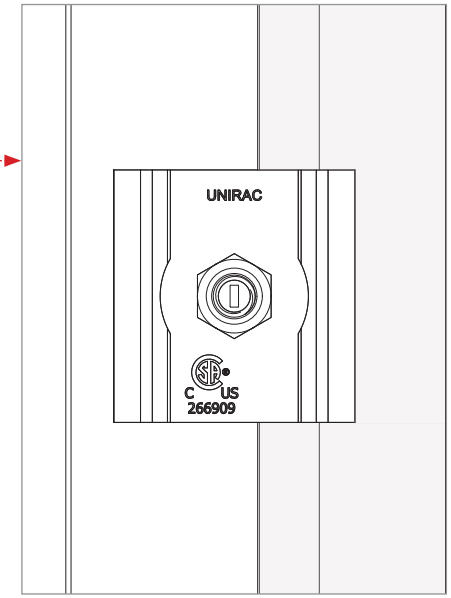
Install Mid Clamps

(Position upright against module but do not torque) When ready - **torque to 11ft-lbs.**





Note - Pro Series Mid Clamps are single use only



Verify that bolt position indicator is perpendicular to E-W beam once nut is torqued