V I N C I & A S S O C I A T E S
Structural Engineers

CLIENT:
Professional Solar Products, Inc. (ProSolar)
1551 S. Rose Ave., Oxnard, CA 93033
Tel: 805-486-4700

Subject: Static load test results for the following :

GroundTrac® Mounting System	Frame Length* (in.)	Frame Width* (in.)	Wind Speed rating (mph per 2012IBC/2013CBC, ASCE 7-10)**
3" x 164XD RoofTrac® rail (4 modules high – landscape)	77	39.5	110
3" x 172XD RoofTrac® rail (4 modules high – landscape)	62	41.5	110
3" x 172XD RoofTrac® rail (4 modules high – landscape)	77	41.5	100
2-1/2" x 124D RoofTrac® rail (3 modules high – landscape)	77	39.5	110
2-1/2" x 136D RoofTrac® rail (4 modules high – landscape)	77	32.5	110

TEST SETUP (as shown in attached drawing detail): Modules were bolted to Professional Solar Products (PSP) RoofTrac® support rails using an assembly of 5/16" stainless steel (ss)bolts, ss lock washers and proprietary aluminum clamps and nuts. The RoofTrac® support rail was attached to a pair of 1-1/2" schedule #40 galvanized water pipes with a proprietary PSP insert and 5/16" "U" bolts. The front to rear span was 9' for the 3" tall Xtra Deep rail design and 7' for the 2-1/2" Deep rail.

Test Procedure (as shown in attached drawing detail): The test set up was top loaded and remained loaded for an approximate period of 30 minutes. The maximum deflection and any signs of permanent deformation were recorded. The test setup was then inverted and loaded to simulate the uplift condition. The setup remained loaded for an approximate period of 30 minutes. The maximum deflection and any signs of permanent deformation were recorded.

Test Results: No permanent deformation.

GroundTrac® Mounting System	Maximum deflection (top load/uplift)
3" x 164XD rail (4 modules high – landscape)	0.688"/0.719"
2-1/2" x 124D rail (3 modules high – landscape)	0.500"/0.344"
2-1/2" x 136D rail (4 modules high – landscape)	0.625"/0.813"

This document certifies the GroundTrac® mounting system used as specified above, achieved stated loads/wind speeds.

Sincerely,

James R. Vinci, S.E.

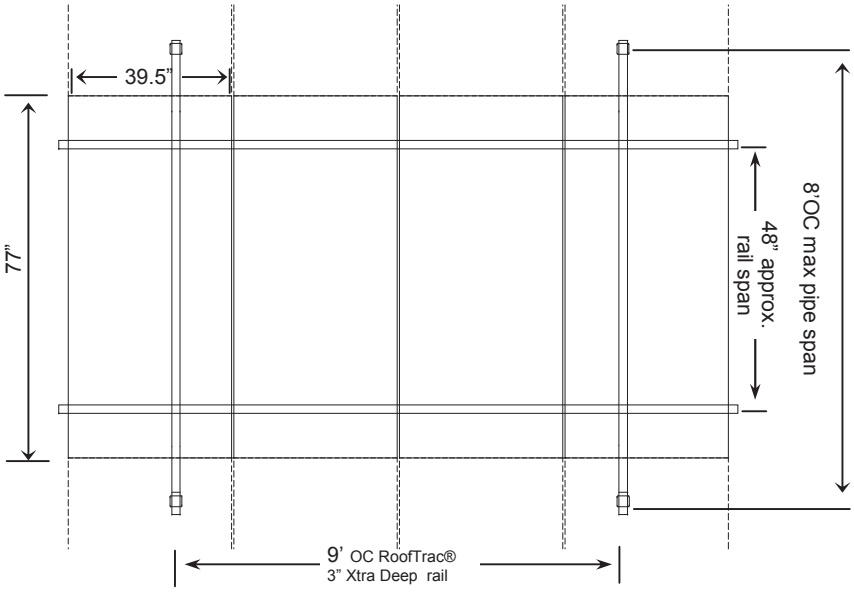
The GroundTrac® mounting system requires installer supplied 1-1/2" schedule #40 galvanized water pipe installed using Hollaender™ structural Tee fittings. All pipe spans referred in this engineering report are absolute maximum limits (see attached detail drawings).

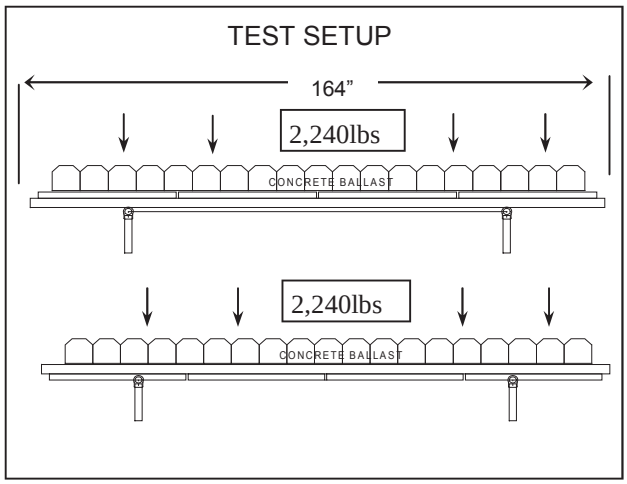
Maximum spans:
60" rear vertical legs height from grade (or top of footing)
30" front vertical leg height from grade (or top of footing)
24" max. pipe cantilever for horizontal pipe
63' single horizontal pipe run recommendation (thermal expansion limit on pipe)

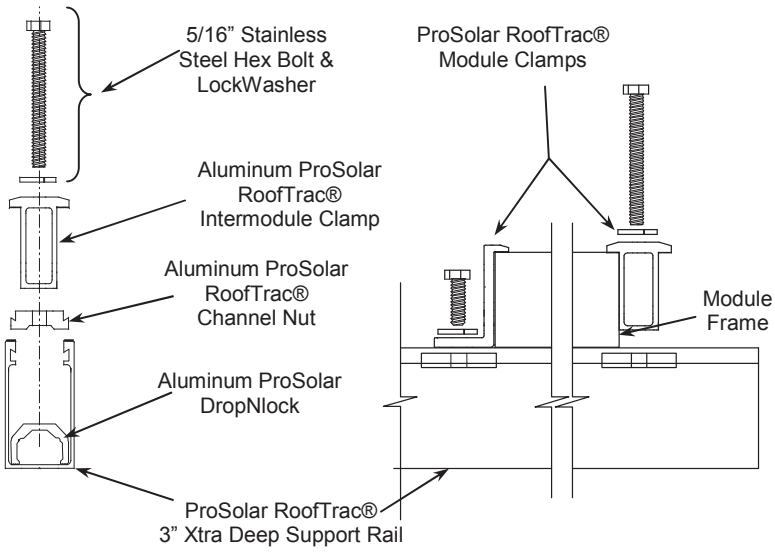
Maximum spans:
3" Xtra deep rail: 8' on center max lateral pipe span (30 psf static)
2-1/2" deep rail: 10' on center max lateral pipe span (50 psf static)
2-1/2" deep rail: 6' on center max snowload lateral pipe span (25 psf- 2.0 safety factor)

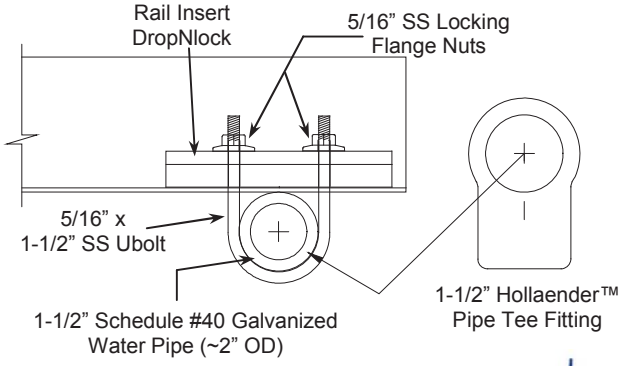
Pipe shall be cut square and completely inserted into the fitting. The Hollaender™ fitting set screw must be torqued to manufacturer specifications of 17 ft-lbs, to meet a minimum of 1,850 pounds of retention.
Footings, per attached drawings must be installed in solid soil at level grade. CBC Table 1806.2, Class 5 soil, 1500 psf soil bearing minimum. Pipe approx. 2" from footing bottom. Contact local building department/AHJ for guidance on unlisted conditions. This office does not field check installations to verify compliance as described in this engineering report. *Modules measuring within stated specifications and UL1703 (or equivalent) listed, are included in this engineering. For 3 high landscape modules on 2-1/2"x136" rail, 43" max module width. 164" rail design derated to 100mph for 172" rail.**Wind loading values relative to defined load values using wind load exposure and gust factor coefficient "exposure C" as defined in the 2012(IBC)/2013(CBC), ASCE 7-10
***1-1/2" schedule 40 water pipe pair tested to: 3,400 lbs at 10' OC max pipe span, 3,740 lbs at 6' OC max pipe span

GroundTrac®
164” x 3” Xtra Deep rail &
172” x 3” Xtra Deep rail



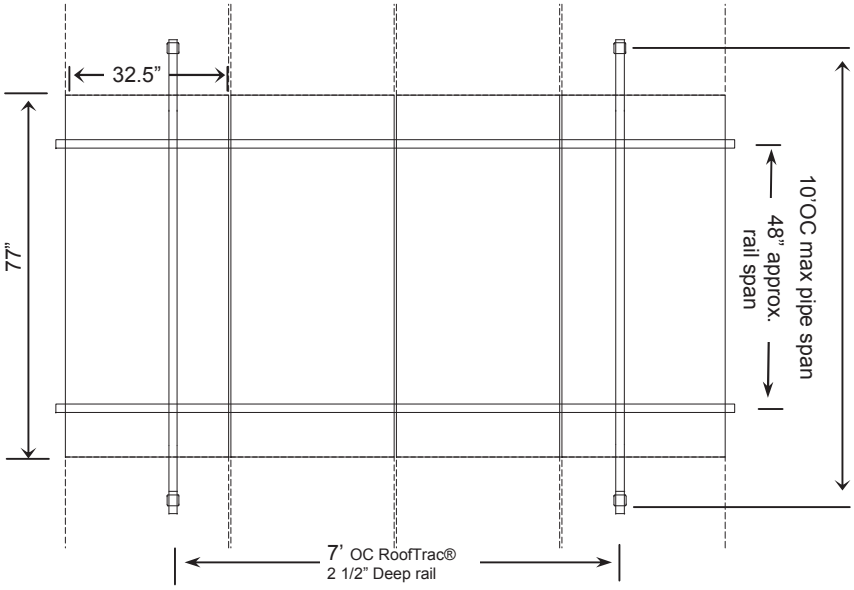


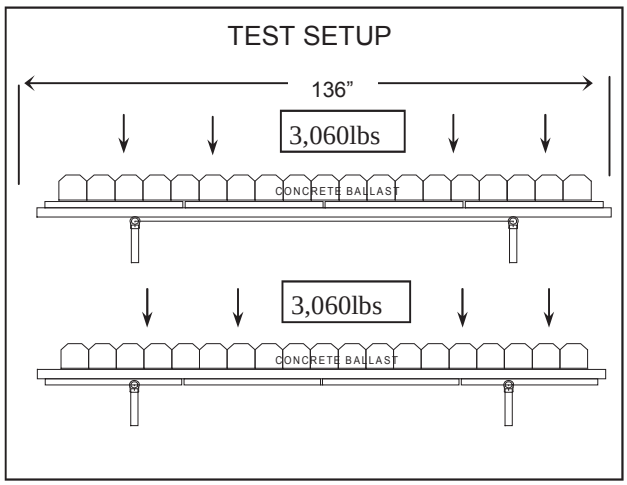


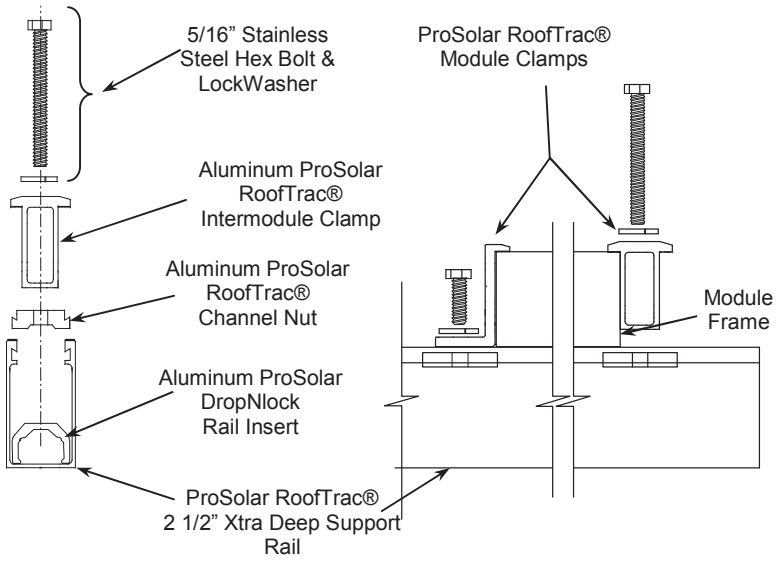


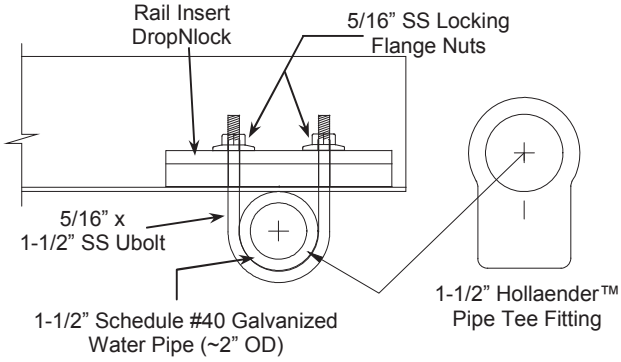
Professional Solar Products GroundTrac®
Photovoltaic mounting system
RoofTrac® Patent# 6,360,491
*172” rail design derated

GroundTrac® 136”x 2 1/2” & 124”x 2 1/2” Deep rail







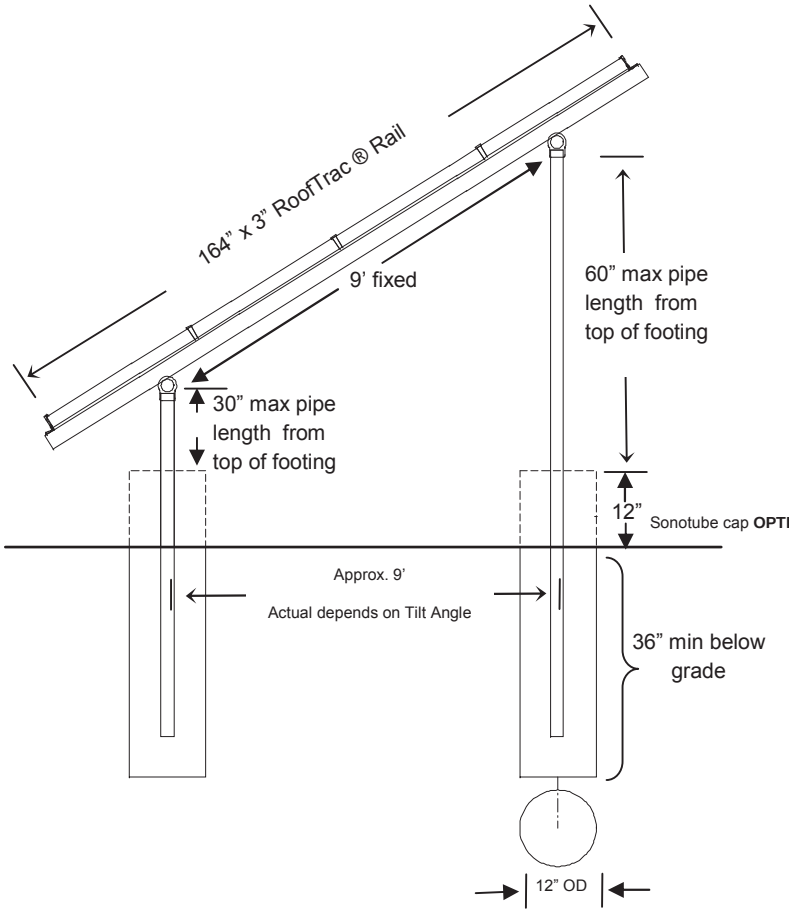


Professional Solar Products GroundTrac®
Photovoltaic mounting system
RoofTrac® Patent# 6,360,491

GT

GroundTrac®

164” x 3” Xtra Deep rail

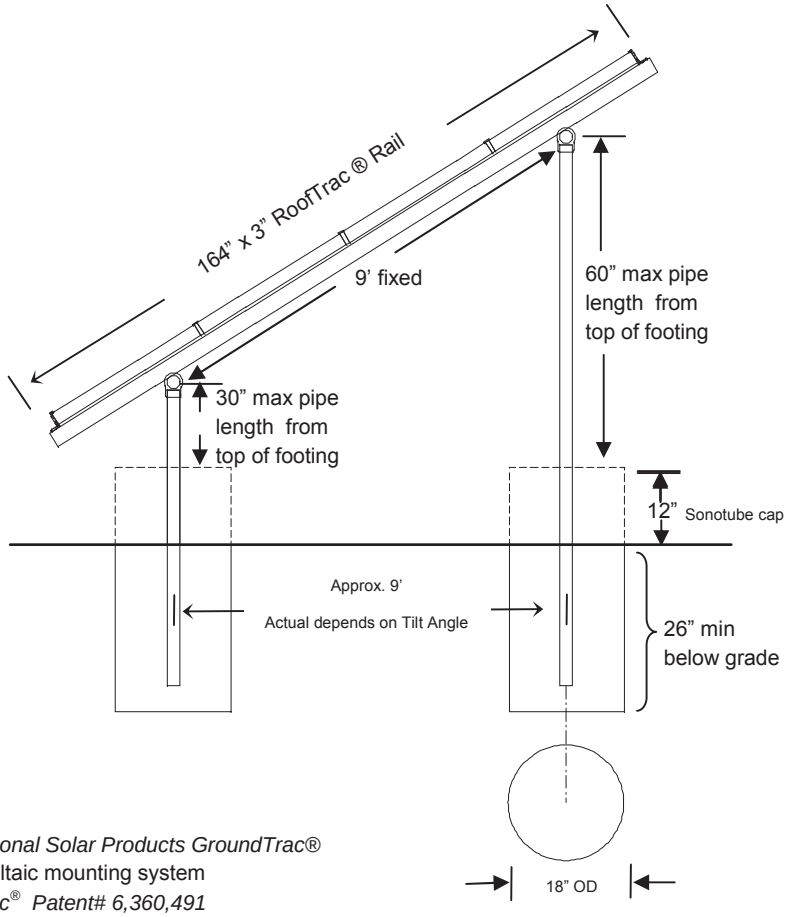


12” OD

$P_{max\ uplift}$ = 1,713 lbs per footing

$P_{max\ footing}$ = 1,302 lbs per footing

Design ratio = 2.4 (3,061 lbs / 1,302 lbs)



18” OD

$P_{max\ uplift}$ = 1,713 lbs per support rail

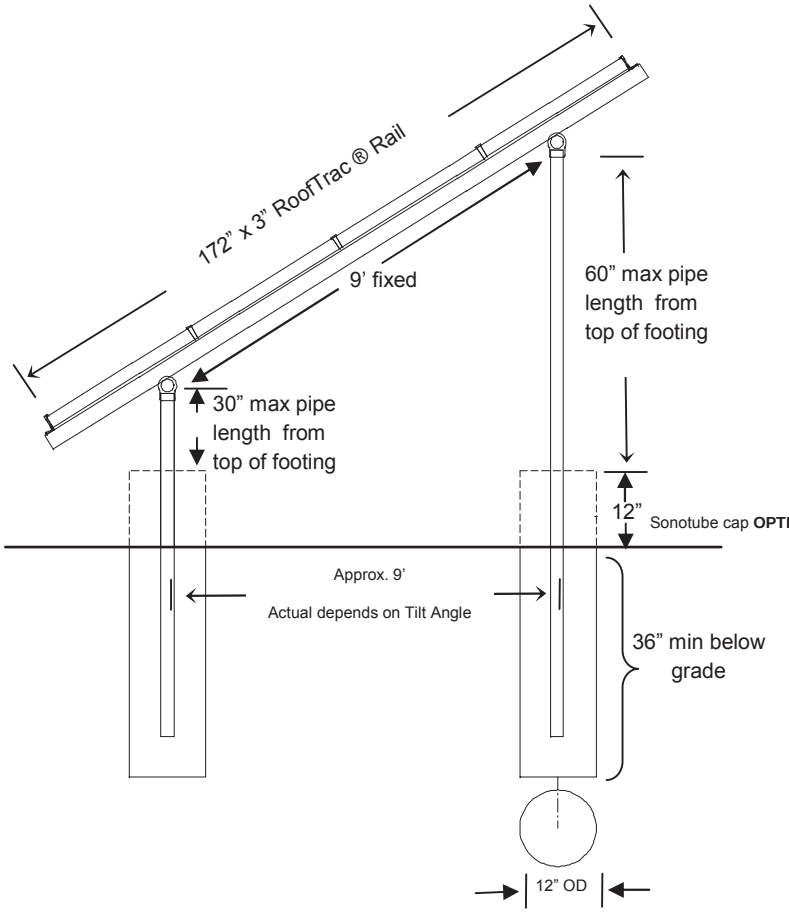
$P_{max\ footing}$ = 1,302 lbs per footing

Design ratio = 2.5 (3,294 lbs / 1,302 lbs)

Professional Solar Products GroundTrac®
Photovoltaic mounting system
RoofTrac® Patent# 6,360,491

GroundTrac®

172” x 3” Xtra Deep rail

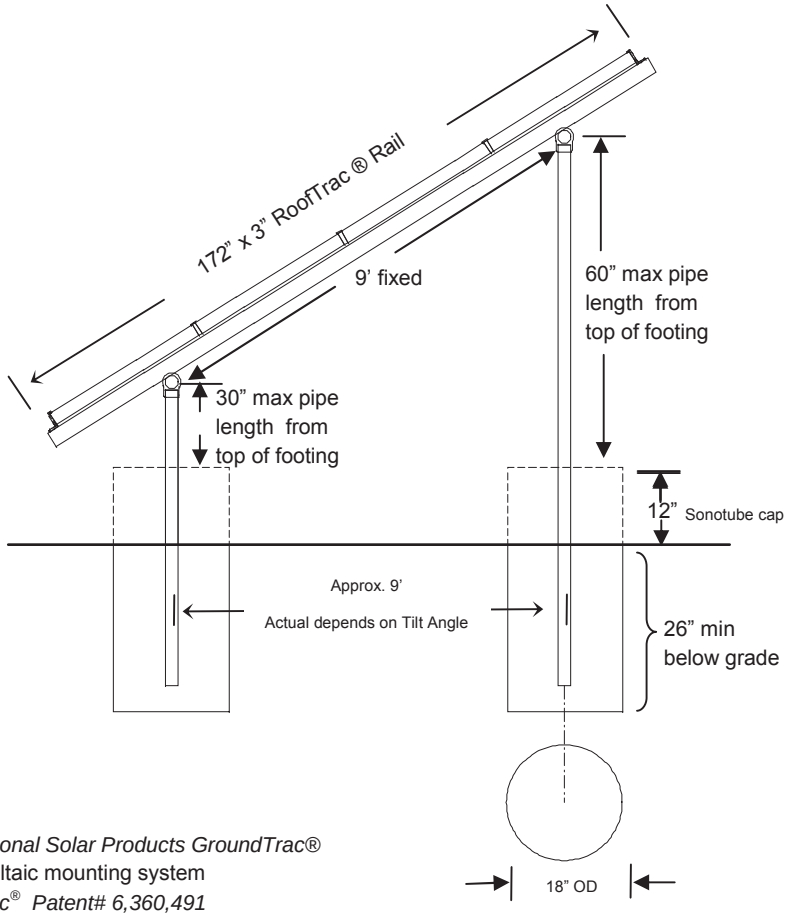


12” OD

$P_{max\ uplift}$ = 1,511 lbs per footing

$P_{max\ footing}$ = 1,102 lbs per footing

Design ratio = 2.6 (2,859 lbs / 1,102 lbs)



18” OD

$P_{max\ uplift}$ = 1,511 lbs per support rail

$P_{max\ footing}$ = 1,102 lbs per footing

Design ratio = 2.8 (3,036 lbs / 1,102 lbs)

REGISTERED PROFESSIONAL ENGINEER
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STRUCTURAL
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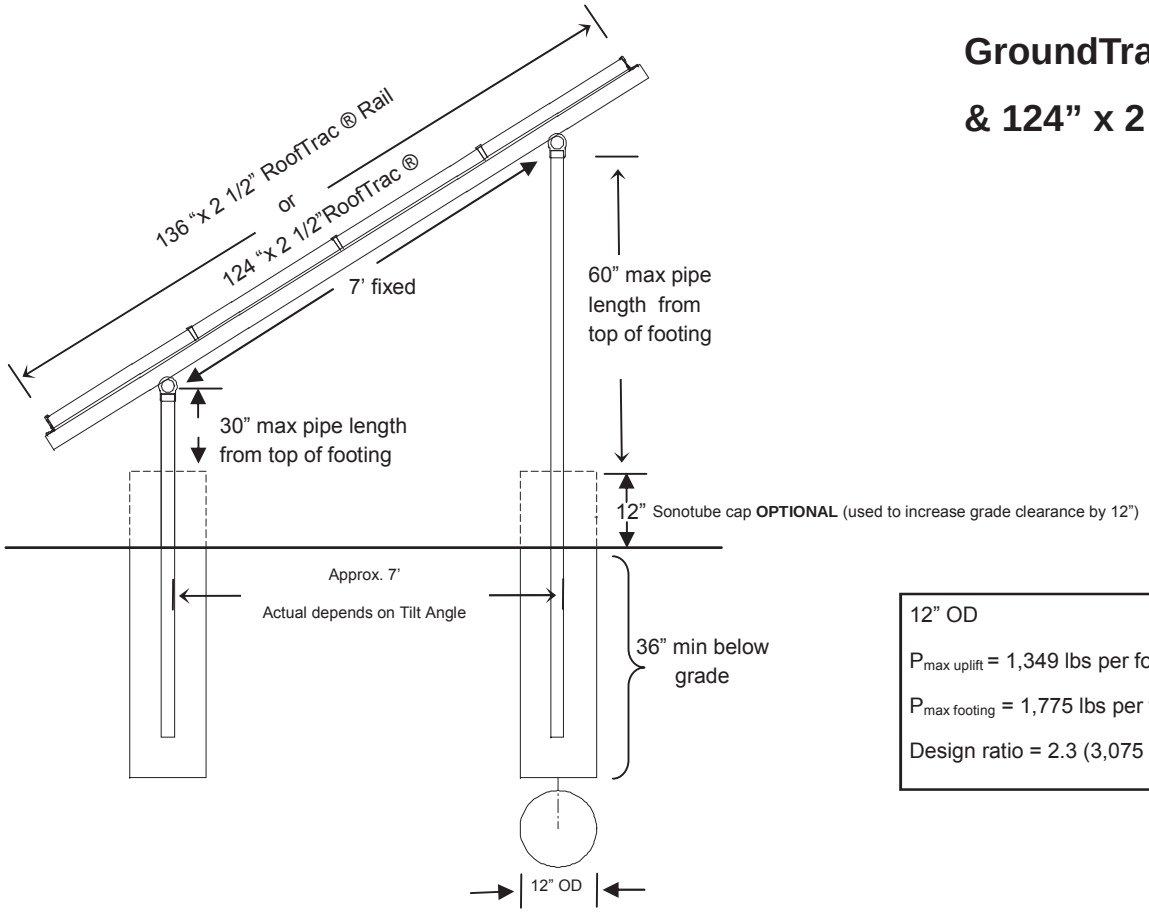
Professional Solar Products GroundTrac®
Photovoltaic mounting system
RoofTrac® Patent# 6,360,491

GroundTrac® 136 x 2 1/2” & 124” x 2 1/2” Deep rail

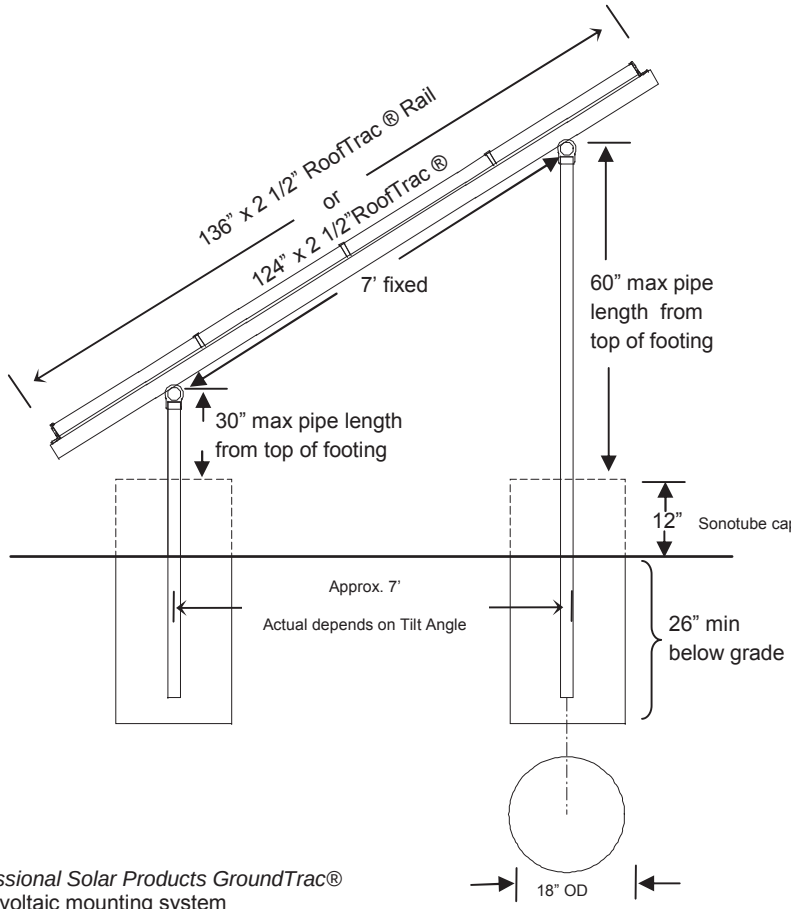


12” OD

$P_{max\ uplift}$ = 1,349 lbs per footing

$P_{max\ footing}$ = 1,775 lbs per footing

Design ratio = 2.3 (3,075 lbs / 1,349 lbs)



18” OD

$P_{max\ uplift}$ = 1,349 lbs per support rail

$P_{max\ footing}$ = 1,775 lbs per footing

Design ratio = 2.4 (3,294 lbs / 1,349 lbs)

Professional Solar Products GroundTrac®
Photovoltaic mounting system
RoofTrac® Patent# 6,360,491

Aluminum-Magnesium Alloy 535.0 Sand Castings
Chemical Composition and Physical Properties

Chemical Composition Limits per ASTM B 26-98

Si	Fe	Cu	Mn	Mg	Ti	Other	Al
0.15	0.15	0.05	0.10-0.25	6.2-7.5	0.01-0.25	0.15	Remainder

Typical Mechanical Properties

Temper	Ultimate Strength (ksi)	Yield Strength (ksi)	Elongation (% in 2 in.)	Shear Strength (ksi)	Compressive Yield Strength (ksi)	Brinell Hardness	Endurance Limit (ksi)
F	40	20	13	27.45	23.5	70	10
	(35 min.)	(18 min.)	(9 min.)			(70 min.)	ASTM B26-98

- Thermal Conductivity (@ 77F, SI units): 0.24 cal/cm*s*K
- Heat Treatment – Achieves its physical and mechanical properties as-cast (F). This eliminates the time and cost of heat treating.
- Machinability – Excellent machinability as-cast, excellent surface finish, and high dimensional stability.
- Corrosion Resistance – Highest of any cast alloy. It can be anodized for additional corrosion protection to a 0.7 mil thickness (215R1).
- Finishing – Produces an excellent surface finish by burnishing or polishing. Anodizes well to a clear-satin finish due to the minimal amount of silicon in the alloy.
- Weldability – It can be welded by any of the inert gas processes, T.I.G. or M.I.G., using filler rod of 5356 or 5183.

Load Capacity of Fitting Set Screws When Properly Torqued

Std. IPS Size Steel Pipe Schedule 40

Fitting Size	Torque Ft. Lbs.	No. Screws	Push Out
3/4"	13	1	1000 lbs.
	13	2	1900 lbs.
1"	14	1	1200 lbs.
	14	2	1800 lbs.
1-1/4"	17	1	1800 lbs.
	17	2	2000 lbs.
1-1/2"	17	1	1850 lbs.
	17	2	2350 lbs.
2"	17	1	1925 lbs.
	17	2	3200 lbs.

Above data compiled by an independent laboratory using the following test procedures: Standard I.P.S.-sized pipe within the vertical barrel of the test fittings, to the torque shown above. A 30,000 lb. Universal Testing Machine applied vertical load to the pipe member in an attempt to produce pipe slippage. Load capacities listed above are based on a safety factor of 2:1.

Aluminum IPS Size Pipe Schedule 40

Fitting Size	Torque Ft. Lbs.	No. Screws	Push Out
1-1/4"	10	1	937 lbs.
	10	2	1006 lbs.
1-1/2"	12	1	950 lbs.
	12	2	1020 lbs.

Above data compiled by an independent laboratory using the following procedures: A 30,000 lb. Universal Testing Machine applied vertical load to the pipe member in an attempt to produce pipe slippage through the vertical barrel of the fitting. Load capacities listed above are based on a safety factor of 100%.

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