

Ground Mounting System

2014 Edition v1.40

This Engineering Design Guide was created to help our engineering partners more easily design and specify PV mounting applications using IronRidge components. In addition to this document, IronRidge provides a complete system of technical support including installation guides, pre-stamped certification letters for most PV-friendly states, our on-line Design Assistant software, and live, knowledgeable person-to-person customer service.

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System Overview

IronRidge provides a comprehensive platform for designing a wide variety of photovoltaic systems for ground mounting applications. Due to its modular architecture, it can handle nearly all commercially available PV modules and can scale to the largest projects. IronRidge products are engineered to last in the most extreme weather conditions and have been installed in every continent in the world.

IronRidge Ground Mounting components are engineered to incorporate locally sourced 2" or 3" schedule 40 pipe to provide a sturdy, cost-effective, and highly scalable solution. The Ground Mount product leverages many of the same components as the Ground Mount. Installers already familiar with the XR1000 rail and mounting components will find that the IronRidge Ground Mount offers an extremely easy-to-install and intuitive experience.

Technical Specifications

Below is a brief summary of the technical specifications of the IronRidge Ground Mount platform. More detail will be provided in the following pages. If there is additional information you require that is not listed in this Engineering Design Guide, please do not hesitate to contact us at support@ironridge.com.

Module Tilt Range	0 to 45 Degrees	Warranty	20 Year
EW Pier Spacing	Up to 17'	Sourced Materials	2" or 3" Schedule 40 Pipe
NS Pier Spacing	7'6"	Bracing	Optional
Max Wind Speed	170 Mph (for 7-10)	Elevation Change	Adapts
Module Orientation	Landscape	T-bolts	Yes
Wind Exposure	Category B, C & D	Wire Clips	Yes
Max Ground Snow Load	90 psf	End Caps	Yes
Materials	Aluminum	All Metal Construction	Yes
	Cast Steel ASTM A216	Engineering Support	Yes (P.E. Certified)
	Stainless Steel Fasteners		

Design Considerations

IronRidge engineers have developed a standard layout and configuration that supports most ground mount requirements. The advantage of this standardized design is that it simplifies the design, engineering, quoting and ordering of the necessary components. Our standard configuration includes the following assumptions:

- Modules in landscape orientation (profile orientation available but not price optimized)
- 2 rails per column of modules
- 14' rails – support ~4-5 modules N-S
- Number of EW columns limited only by thermal expansion constraints
- North & South piers set at 7'6" apart

If a non-standard array configuration is desired, please contact IronRidge support.

Assembled View





Substructure

Top Caps



Connect vertical and horizontal pipes.

Rail Connectors



Attach Rail Assembly to horizontal pipes.

Diagonal Braces



Provide additional support where required.

Schedule 40 Pipes



Locally-sourced pipes serve as primary structure.

Rail Assembly

XR1000 Rails



Curved rails increase spanning capabilities.

Top-Down Clamps



Secure modules to rails and substructure.

Under Clamps



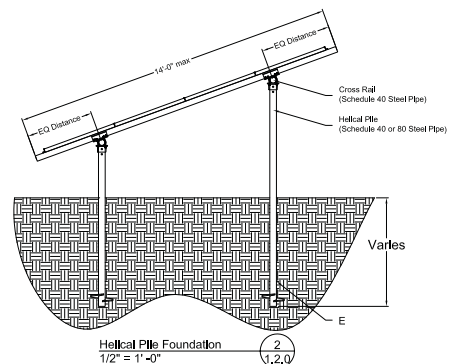
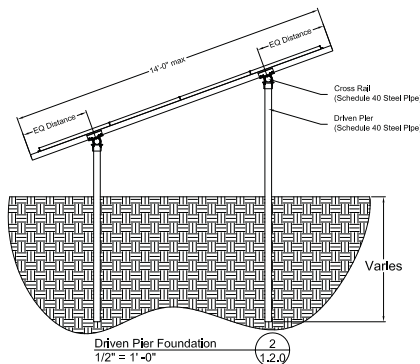
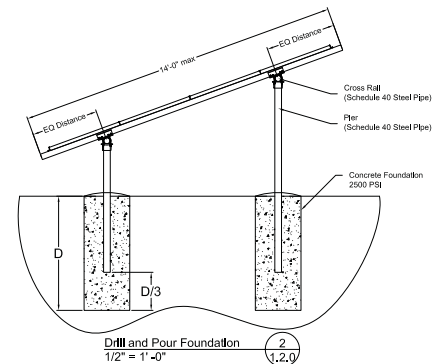
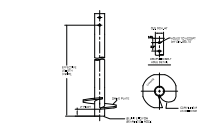
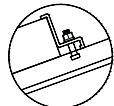
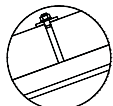
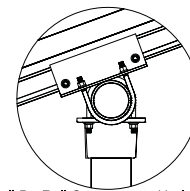
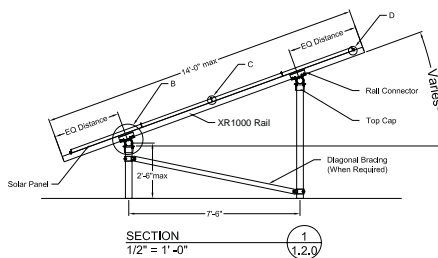
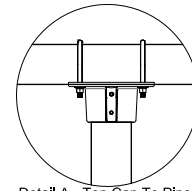
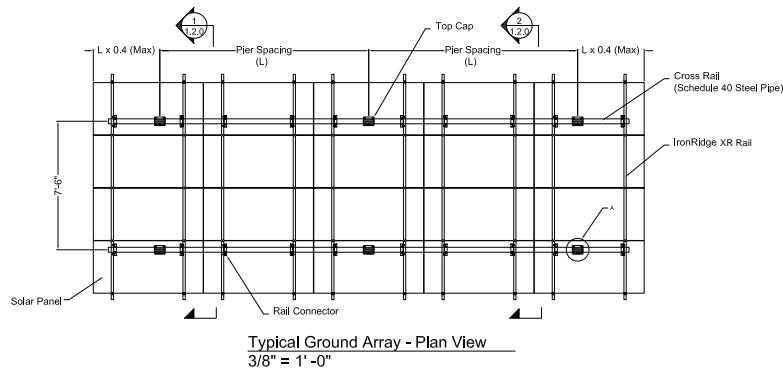
Alternative clamps for pre-attaching modules to rails.

Accessories



Wire Clips and End Caps provide a finished look.

Assembly Details

[Download AutoCAD File](#) | [Download PDF](#)


Top Cap

The IronRidge Top Caps facilitate the quick and easy construction of a Schedule 40 substructure. Available in sizes that fit either 2" or 3" Schedule 40 pipe, this Top Cap secures quickly to multiple pier types with 3 set screws and also supports cross piping (schedule 40) with U-bolt hardware.



Property	Value
Material	ALMAG 535
Finish	Mill
Top Cap Sizes	2" and 3"
2" Top Cap Dimensions	3" x 4.5" x 5" (H x W x L)
Weight (2")	4.3 Lbs
3" Top Cap Dimensions	3.5" x 6" x 7.5" (H x W x L)
Weight (3")	6.47 Lbs
Hardware	3/8" SS

Schedule 40 Pipe

The IronRidge Ground Mount platform leverages 2" or 3" Schedule 40 Steel Pipe as the primary structural element. This component can be sourced locally to assist installers in reducing shipping costs and shortening delivery times. ASTM A53 Grade B standard weight (schedule 40) steel pipes or structural equivalent is necessary. Minimum geometry and material properties listed below.



Property	Value
Material	A53 GR B (SCH 40)
Yield Strength (ksi)	35 ksi (min)
Finish	Hot-Dipped Galvanized
3" Pipe	OD 3.5", 0.216" Wall Thickness
2" Pipe	OD 2.38", 0.154" Wall Thickness
Locally Sourced	Yes
Typical Lengths	20', 24', 40'

XR1000 Rail

The IronRidge XR1000 Rail is a high performance rail that spans over twelve feet under typical load conditions. This rail has slots for both top and bottom PV module mounting and is manufactured using extruded aluminum alloys. The XR1000 Rail supports the PV modules on top of the Schedule 40 sub-structure. Use two rails for each column of modules.



Property	Value
Material	6005A-T5, 6105-T6
Finish	Clear Anodized
Beam Height	3.00"
Weight / Linear Foot	.945 Lbs
Total Cross-Sectional Area	.807 In ²
Section Modulus (X-axis)	.530 In ³
Moment of Inertia (X-axis)	.843 In ⁴
Moment of Inertia (Y-axis)	.182 In ⁴
Torsional Constant	.436 In ³
Polar Moment of Inertia	0.3299 In ⁴

Rail Connector

Our Rail Connectors secure IronRidge XR1000 Rails to the Schedule 40 horizontal cross pipes. Each XR1000 Rail requires two connectors to create a secure attachment.



Property	Value
Material	6105-T5
Finish	Mill
Rail Connector Sizes	2" and 3"
Height (Bracket)	3"
Width (Bracket)	2"
Length (Bracket)	8"
Weight	1 Lbs
Hardware	5/16", 3/8" SS

Diagonal Brace

The optional Diagonal Brace Assembly kit is for installations that require extra support. This diagonal brace kit includes the brace, sleeves, and hardware for installation between one north and south pair of support legs. Our Rail Connectors secure IronRidge XR1000 Rails to the Schedule 40 horizontal cross pipes. Each XR1000 requires two connectors to create a secure attachment.



Property	Value
Material (Tube)	6061-T6
Finish (Tube)	Mill
Sizes (Tube)	2", 2.5" Square Tube
Length (Tube)	7.5' and 9'
Weight (Tube)	15 and 19 Lbs Material
(Sleeves)	Galvanized Steel
Sleeve Sizes	2", 3"
Hardware	3/8" SS

End Clamp

IronRidge End Clamps secure PV modules to the Rails using the top slot of these rails. Our Clamps are independent of the module's mounting holes.



Property	Value
Material	5052-H32
Finish	Mill & Black
Height	Varies depending on Module
Width	1.5"
Depth	1.5"
Weight	0.054 Lbs (avg.)
Hardware	1/4"-20 SS Nut and Bolt

Mid Clamps

IronRidge Mid Clamps secure PV modules to the rail when there are multiple modules in a row. The Mid Clamp fits between two adjacent modules, providing clamping pressure to both modules simultaneously. The Mid Clamps are not dependent upon the PV module's mounting holes and fit to the top slots of our XR1000 Rails.



Property	Value
Material	5052-H32
Finish	Mill & Black
Spacing between Modules	1/4"
Width	1"
Depth	1.5"
Weight	0.02 Lbs
Hardware	1/4"-20 SS Nut and Bolt

Under Clamps

IronRidge Under Clamps secure PV modules to the XR1000 Rail using the mounting holes of the PV module and the side slot of the rail.



Property	Value
Material	6000 Series Aluminum
Finish	Mill
Spacing between Modules	1/4"
Width	1.6"
Depth	1.5"
Weight	0.05 Lbs
Hardware	1/4"-20 SS Nut and Bolt

Wire Clips

IronRidge Wire Clips snap into the top slot of XR Rails, and accommodate up to ten 5mm panel wires, or one MC4, one Enphase wire and one dual Enphase wire. The Wire Clips are molded from black polycarbonate with UV protection.



Property	Value
Material	Polycarbonate
Finish	Black
UV Protection	Yes
Weight	0.01 Lbs

End Caps

End caps provide a finished look while protecting against the collection of water and debris inside the rail.



Property	Value
Material	Polycarbonate
Finish	Black
UV Protection	Yes
Weight	0.02 Lbs

Grounding

Wiley grounding clips (WEEB DMC) are used in conjunction with the IronRidge Mid Clamps for grounding PV modules to the XR1000 Rails. Order one grounding clip for every two Mid Clamps used.



Property	Value
Material	304 Stainless Steel
ETL Listed	ANSI/UL 467 Compliant
Maximum Conductor Size	6 AWG (with two WEEBs contacting each module)
Hardware	None

Wiley grounding lugs are used in conjunction with copper wire to provide a continuous ground for every row of rails.



Property	Value
WEEB Material	304 Stainless Steel
Lug Material	Tin-plated Copper
ETL Listed	ANSI/UL 467 Compliant
Ground Conductor	One 14 AWG to 6 AWG or two 10 AWG, two 12 AWG
Hardware	1/4"-20 & 1/4"-28 SS

Summary

With the IronRidge Design Assistant™ our customers move from laboriously designing systems across the span of weeks, to intuitively designing while pricing, bill of materials and engineering calculations all update in real-time.

If you register for an online account, you will then be able to save your work and prevent losing your project's configuration settings between sessions.

The application is so quick and easy to use, multiple what-if scenarios can be evaluated through immediate engineering and pricing feedback. Engineered calculations comply with ASCE 7-10 building codes for expedited P.E. approval.

The IronRidge Design Assistant™ is provided free of charge to IronRidge customers.

Design, engineer and quote, online, in just minutes.

ironridge.com/support/designassistant



Code Compliance

IronRidge Ground Mount components, when installed in accordance with the IronRidge Ground Mount Installation Manual, will be structurally adequate and will meet the structural requirements of:

- ASCE/SEI 7-10 Min. Design Loads for Buildings & Other Structures
- California Building Code 2013 Edition
- AC428, Acceptance Criteria for Modular Framing Systems Used to Support PV Modules, Effective November 1, 2012 (ICC-ES)
- Aluminum Design Manual, 2010 Edition
- Florida Building Code 2010 Edition
- Florida Residential Building Code 2010 Edition
- International Building Code 2012 Edition
- International Residential Building Code 2012 Edition

Engineering Assumptions

The procedures for calculating the engineering values are based on the following assumptions:

1. Concrete Weight = 145 pcf / $f'_c = 2500$ psi
2. Skin Friction per 2006 IBC 1808.2.8.4 & 5, 2009 IBC 1810.3.3.1.4 & 5
3. Top 1'-0" of soil neglected for Skin Friction
4. Snow Load = 0 psf - tabulated values are conservative for Snow Loads > 0 psf
5. Resistance to corrosion and/or sulfate attack, along with possible adverse effects due to expansive soils has not been considered in foundation recommendations. SML Engineers assumes no liability with regard to these items.
6. Soil classification is to be determined and verified by the end user of this certification letter.

For conditions outside these assumptions, please use the IronRidge Design Assistant or contact IronRidge customer service.

Ground Array Components

Part Number	Description	Weight	Packaging
70-0200-SGA	SGA Top Cap at 2"	4.30 Lbs	Kit of 1; Box of 40
70-0300-SGA	SGA Top Cap at 3"	6.47 Lbs	Kit of 1; Box of 40
29-7001-001	SGA Rail Connector at 2"	1.03 Lbs	Kit of 1; Box of 70
29-7001-000	SGA Rail Connector at 3"	1.03 Lbs	Kit of 1; Box of 70
70-0200-CBR	SGA 2" (7.5') Brace Assembly	21.38 Lbs	Box of 4
70-0300-CBR	SGA Rail Connector at 3"	26.78 Lbs	Box of 4

Rails

The rails for the standardized Ground Mount configuration are set at 14'.

Part Number	Description	Weight	Packaging
XR-1000-132A	XR1000, Rail 132" (11 Feet), Clear	11.24 Lbs	Sub-bundles of 4; Bundles of 80
XR-1000-168A	XR1000, Rail 168" (14 Feet), Clear	14.30 Lbs	Sub-bundles of 4; Bundles of 80

Clamps

Module Clamp size depends on the module thickness. Use the table below to determine which Module Clamp will fit your projects module thickness.

Module Thickness		Clamp Info		Part Numbers		
Mm	Inches	Clamp Type	Bolt Height	End Clamp	Mid Clamp (hex)	Mid Clamp (tbolt)
31.0 - 32.5	1.22 - 1.28	I	2.00"	29-7000-125	29-7000-105	29-70TB-105
33.3 - 34.8	1.31 - 1.37	A	2.00"	29-7000-134	29-7000-105	29-70TB-105
34.8 - 36.8	1.37 - 1.45	B	2.00"	29-7000-224	29-7000-105	29-70TB-105
39.0 - 41.0	1.53 - 1.61	C	2.25"	29-7000-157	29-7000-101	29-70TB-101
41.1 - 42.7	1.62 - 1.68	J	2.25"	29-7000-165	29-7000-101	29-70TB-101
42.7 - 44.2	1.68 - 1.74	E	2.25"	29-7000-171	29-7000-101	29-70TB-101
45.0 - 47.0	1.77 - 1.85	F	2.50"	29-7000-214	29-7000-108	29-70TB-108
46.7 - 48.3	1.84 - 1.90	K	2.50"	29-7000-187	29-7000-108	29-70TB-108
49.0 - 51.1	1.93 - 2.01	G	2.50"	29-7000-204	29-7000-108	29-70TB-108
57.4 - 58.9	2.26 - 2.32	H	2.75"	29-7000-230	29-7000-104	29-70TB-104

End Clamps

End Clamps depend on the module thickness. Match the clamp type with the module thickness and order the corresponding end clamp part numbers.

Part Number	Description	Weight	Packaging
29-7000-125	Kit, 4pcs, End Clamp I, 1.25", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-134	Kit, 4pcs, End Clamp A, 1.34", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-224	Kit, 4pcs, End Clamp B, 1.41", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-157	Kit, 4pcs, End Clamp C, 1.57", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-165	Kit, 4pcs, End Clamp J, 1.65", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-171	Kit, 4pcs, End Clamp E, 1.71", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-214	Kit, 4pcs, End Clamp F, 1.81", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-187	Kit, 4pcs, End Clamp K, 1.87", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-204	Kit, 4pcs, End Clamp G, 1.97", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-230	Kit, 4pcs, End Clamp H, 2.30", Mill	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-125B	Kit, 4pcs, End Clamp I, 1.25" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-134B	Kit, 4pcs, End Clamp A, 1.34" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-224B	Kit, 4pcs, End Clamp B, 1.41" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-157B	Kit, 4pcs, End Clamp C, 1.57" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-165B	Kit, 4pcs, End Clamp J, 1.65" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-171B	Kit, 4pcs, End Clamp E, 1.71" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-214B	Kit, 4pcs, End Clamp F, 1.81" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-187B	Kit, 4pcs, End Clamp K, 1.87" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-204B	Kit, 4pcs, End Clamp G, 1.97" Black	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-230B	Kit, 4pcs, End Clamp H, 2.30" Black	0.3 Lbs	Kits of 4; Boxes of 200

Mid Clamps

Part Number	Description	Weight	Packaging
29-7000-105	Kit, 4pcs, Mid Clamp A/B/I, 2.00", Mill (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-101	Kit, 4pcs, Mid Clamp C/D/J/E, 2.25", Mill (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-108	Kit, 4pcs, Mid Clamp F/K/G, 2.50", Mill (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-104	Kit, 4pcs, Mid Clamp H 2.75", Mill (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-105	Kit, 4pcs, Mid Clamp A/B/I, 2.00", Mill (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-101	Kit, 4pcs, Mid Clamp C/D/J/E, 2.25", Mill (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-108	Kit, 4pcs, Mid Clamp F/K/G, 2.50", Mill (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-104	Kit, 4pcs, Mid Clamp H, 2.75", Mill (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-105B	Kit, 4pcs, Mid Clamp A/B/I, 2.0", Black (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-101B	Kit, 4pcs, Mid Clamp C/D/J/E, 2.25", Black (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-108B	Kit, 4pcs, Mid Clamp F/K/G, 2.5", Black (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-7000-104B	Kit, 4pcs, Mid Clamp H, 2.75", Black (Hex)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-105B	Kit, 4pcs, Mid Clamp A/B/I, 2.00", Black (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-101B	Kit, 4pcs, Mid Clamp C/D/J/E, 2.25", Black (Tbolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-108B	Kit, 4pcs, Mid Clamp F/K/G, 2.50", Black (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200
29-70TB-104B	Kit, 4pcs, Mid Clamp H, 2.75", Black (T-bolt)	0.3 Lbs	Kits of 4; Boxes of 200

Under Clamps

Part Number	Description	Weight	Packaging
29-7000-117	Kit, 4pcs, Under Clamp	0.4 Lbs	Kits of 4; Boxes of 200

Accessories

Part Number	Description	Weight	Packaging
XR-1000-CAP	XR1000 Rail, End Cap (Polybag, 20)	7 Lbs/Box	20 End Caps/Bag; 500 Caps/Box
29-4000-077	Wire Clip (Polybag, 20)	6.70 Lbs/Box	20 Clips/Bag; 500 Clips/Box
29-5003-005	Kit, 1/4 x 3/4 Microinverter Mounting	10.30 Lbs/Box	150 Kits/Box
29-50TB-005	Kit, 1/4 x 3/4 Microinverter Mounting, T-Bolt	10.30 Lbs/Box	150 Kits/Box

Grounding

Part Number	Description	Weight	Packaging
29-4000-001	WEEB DMC Compression Clip	.50 Lbs/Box	100 Clips/Box
29-4000-002	WEEB Grounding Lug	12.45 Lbs/Box	100 Lugs/Box

System Support

IronRidge provides a complete system of technical support including installation guides, ultra-fast project-specific certification letters for most PV-friendly states, our online Design Assistant software, and live, knowledgeable person-to-person customer service.

Downloadable Support Documents

Our website at www.ironridge.com/products/groundmounting/systemsupport contains all of the technical support information necessary to design, quote, certify, and install an IronRidge Ground Mount system. The specific documents that can be found here include:

- CAD files (AutoCAD format)
- Engineering Design Guide
- Pre-stamped Certification Letters
- Installation Guides
- Parts Catalog

3rd Party Partners

We've engineered best-of-class 3rd party solutions with our Ground Mount platform to further improve the quality we offer customers. Where appropriate, pre-stamped certification letters are included to simplify and expedite the design, quoting, and permitting processes. At this time, we work with products from the following companies:

- US Wholesale Pipe & Tube
- BestBase Foundation Systems
- Cantsink

Design Assistant

The IronRidge Design Assistant automates much of the Design and Engineering phases of a project. Easily accessible from our website, the Design Assistant provides a highly intuitive layout interface, automatically calculates critical engineering information based on your project's specific load conditions, provides the ability to add optional components, and determines an accurate bill of materials and quotation.

The Ground Mount Design Assistant can be accessed at: ironridge.com/gm

Engineering Services

IronRidge provides pre-stamped certification letters for many standard load conditions. These letters are available in most PV-friendly states and a few countries including: (italicized states are in progress as of May 2012)

Arizona	Georgia	Minnesota	<i>North Carolina</i>	Tennessee
California	Hawaii	Missouri	Ohio	Texas
Colorado	<i>Illinois</i>	Nevada	Oklahoma	Utah
Connecticut	Louisiana	New Hampshire	Oregon	Virginia
D.C.	Massachusetts	New Jersey	Pennsylvania	Vermont
Delaware	Maryland	New Mexico	<i>Rhode Island</i>	Washington
Florida	<i>Maine</i>	New York	<i>South Carolina</i>	

We can also provide non-standard certifications, wet-stamped letters, or specialized engineering requests. Our preferred engineering firm is Starling Madison Lofquist, Inc. Their contact information is:

Starling Madison Lofquist, Inc.
5224 South 39th Street
Phoenix, Arizona 85040
Phone: 602-438-2500

Customer Service

The IronRidge support staff is knowledgeable, experienced, friendly, and responsive. We would be happy to provide assistance on any questions you may have. Please feel free to contact us through your preferred method at:

Email: support@ironridge.com
Phone: 800-227-9523

Warranty Information

Effective for IronRidge, Inc. ("IronRidge") mounting structure components ("Products") manufactured after April 1st, 2012, IronRidge provides the following warranties, for Products installed properly and used for the purpose for which the Products are designed:

- finishes shall be free of visible defects, peeling, or cracking, under normal atmospheric conditions, for a period of three (3) years from the earlier of (i) the date of complete installation of the Product or (ii) thirty days after the original purchaser's date of purchase of the Product ("Finish Warranty");
- components shall be free of structurally-related defects in materials for a period of ten (10) years from the earlier of (i) the date of complete installation of the Product or (ii) thirty days after the original purchaser's date of purchase of the Product;
- components shall be free of functionally-related manufacturing defects for a period of twenty (20) years from date of manufacture.

The Finish Warranty does not apply to: (a) surface oxidation of the galvanized steel components or any foreign residue deposited on Product finish; and (b) Products installed in corrosive atmospheric conditions, as defined solely by IronRidge; corrosive atmospheric conditions include, but are not limited to, conditions where Product is exposed to corrosive chemicals, fumes, cement dust, salt water marine environments or to continual spraying of either salt or fresh water. The Finish Warranty is VOID if (c) the practices specified by AAMA 609 & 610-02 – "Cleaning and Maintenance for Architecturally Finished Aluminum" (www.aamanet.org) are not followed by Purchaser for IronRidge's aluminum based components; and (d) if the practices specified by ASTM A780 / A780M - 09 "Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings" are not followed by Purchaser for IronRidge's galvanized steel-based components.

The warranties above do not cover any parts or materials not manufactured by IronRidge, and exclude non-functionally-related defects, as defined solely by IronRidge. The warranties do not cover any defect that has not been reported to IronRidge in writing within twenty (20) days after discovery of such defect.

In the event of breach of or non-compliance with the

warranties set forth above, IronRidge's sole obligation and liability, and the sole and exclusive remedy for such breach or non-compliance, shall be correction of defects by repair, replacement, or credit, at IronRidge's sole discretion. Such repair, replacement or credit shall completely satisfy and discharge all of IronRidge's liability with respect to these warranties.

Refurbished Product may be used to repair or replace the defective components. Transportation, installation, labor, or any other costs associated with Product replacement are not covered by these warranties and are not reimbursable. These warranties additionally do not cover (a) normal wear, or damage resulting from misuse, overloading, abuse, improper installation (including failure to follow professional instruction and certification), negligence, or accident, or from force majeure acts including any natural disasters, war or criminal acts; and (b) Products that have been altered, modified or repaired without written authorization from IronRidge or its authorized representative; and (c) Products used in a manner or for a purpose other than that specified by IronRidge. A formal document proving the purchase and the purchase date of the Product is required with any warranty claim.

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