

Attn: Sean McDonald, CEO IronRidge Inc.

Date: September 28th, 2023

Re: Structural Certification for QuickMount Halo UltraGrip™ Roof Attachment – Rafter Attached

This letter certifies the structural capacity of the QuickMount Halo UltraGrip™ (*HUG*) for use as a roof attachment with flush mounted PV solar systems, when attached to a roof rafter. *HUG* consists of a cast aluminum base with a 2" long vertical open-end slot for connection of a rail system. An UltraGrip™ Flashing Technology is affixed to the underside of the *HUG* base. *HUG* is secured to a roof rafter using No. 14 x 3" structural wood screws. Screws shall be installed in accordance with the *QuickMount Halo UltraGrip™* installation manual. Full assembly details are shown in Exhibit EX-0023.

The structural capacities of *HUG* are reviewed along four respective load directions including uplift, compression, lateral parallel to the rafter, and lateral perpendicular to the rafter for base orientations that represent rail running cross-slope or up slope in relation to roof pitch. The capacity ratings are based on structural load tests performed using a Universal Instron Test Unit according to ASTM D1761-20 "*Standard Test Methods for Mechanical Fasteners in Wood and Wood Based Materials*". For each load test a *HUG* was installed onto a sample roof deck composed of 7/16" OSB Board over 2x4 rafters as shown in Figure 1. The moisture content and the specific gravity of the rafters were measured per ASTM D2395-17 "*Standard Test Methods for Density and Specific Gravity (Relative Gravity) of Wood and Wood-Based Materials*". The recorded moisture content of the rafters among all sample roof decks was between 12% and 14% and the rafter specific gravity was 0.42. For each load test, the point load was placed at the highest position allowed in the open-end slot. The tested *HUG* was installed to the roof rafter using two (2) 3" long No. 14 stainless steel structural wood screws installed within the middle third of the rafter.

The failure observed during uplift load testing was splitting of the 2x4 rafter at the peak load of 3011 lbs. For the rafter splitting failure, a safety factor of 3 per ASTM D7147 is applied to the uplift peak load, which provides an **allowable uplift capacity of 1004 lbs**. The allowable uplift capacity is applicable to roof decks with a rafter specific gravity greater than or equal to 0.42, which was the average wood specific gravity recorded in the uplift load tests.

The failure observed during compression load testing was rupture of the OSB deck under the *HUG* at the peak load of 5221 lbs. For the deck rupture failure, a safety factor of 2.54 per NDS 2018 is applied to the peak load which provides an **allowable compression capacity of 2056 lbs**.

For each lateral load direction, the *HUG* was tested in the worst-case condition with the load placed at the highest position allowed in the vertical slot. For lateral load parallel to the rafter, the critical failure mode which results in the lowest allowable capacity was observed to be fastener withdrawal at a peak load of 1103 lbs. For the fastener withdrawal failure mode, a safety factor of 3.0 is applied per ASTM D7147 which provides an **allowable lateral capacity of 368 lbs**. For lateral load perpendicular to the rafter the critical failure mode is fastener shearing at a peak load of 720 lbs. For the screw shearing failure mode, safety factor of 3.0 per AISI S100 applied which provides an **allowable lateral capacity of 240 lbs**.

Please note the provided test investigation and its associated results described herein were based on load tests performed on the *HUG* as a stand-alone roof attachment. It is not the intention of this letter to rate or certify structural components other than those specifically delineated in this letter. This evaluation excludes the structural adequacy of the chosen PV modules and underlying roof supporting members. For those, it shall be the responsibility of the designated system designer or project engineer to verify the structural capacity and adequacy regarding the applied or resultant loads of the chosen array configuration.

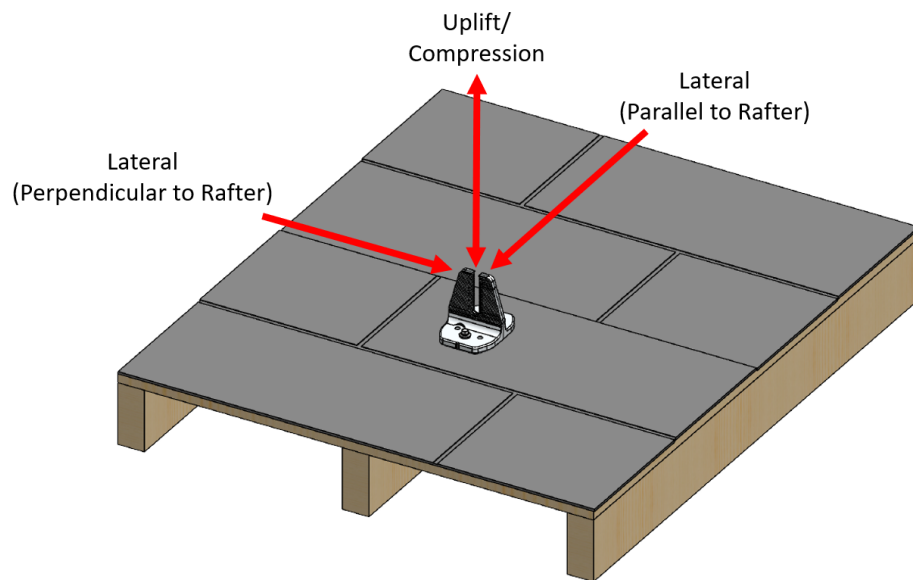


Figure 1: QuickMount Halo UltraGrip™ and Applied Loading Directions

Table 1: QuickMount HUG Allowable Capacities ⁽¹⁾						
Load Direction	Test Quantity	Critical Failure Mode	Safety Factor ⁽⁵⁾	Avg. Ultimate Capacity (lbs.)	Max deviation from mean ⁽⁴⁾	Allowable Capacity (lbs.) ⁽⁶⁾
Uplift ⁽²⁾	8	Rafter Splitting	3.0	3011	16.5%	1004
Compression ⁽³⁾	5	OSB Deck Rupture	2.54	5221	9.2%	2056
Lateral Parallel to Rafter	8	Fastener Withdrawal	3.0	1103	21.8%	368
Lateral Perpendicular to Rafter	5	Screw Shearing	3.0	720	5.1%	240

Table 1 Notes:

- (1) Capacities apply to a roof structure with a minimum size of a 2x4 rafter, and a minimum roof deck thickness of 7/16" using 3" long No. 14 wood screws installed per the QuickMount *HUG Installation Guide*. Rafters and roof deck should be in sound structural conditions with no sign of rot, decay, previous installation, or pre-existing damages.
- (2) The uplift direction is upward perpendicular to the roof surface. The uplift capacity shall be used when the direct supporting rafter has a specific gravity of 0.42 or greater.
- (3) The compression direction is downward perpendicular to the roof surface.
- (4) Deviation reflects the variance of the highest or the lowest test value from the group mean for the respective load direction. For load directions where deviation was larger than 10% after 5 tests, 3 additional tests are added per *ADM-2020* Appendix 1.
- (5) Safety Factor is based on the respective failure mode observed and determined per *NDS 2018*, *ASTM 7147-21* and *AISI S100-16*
- (6) Allowable capacity is equal to Average Ultimate Capacity divided by its associated Safety Factor.

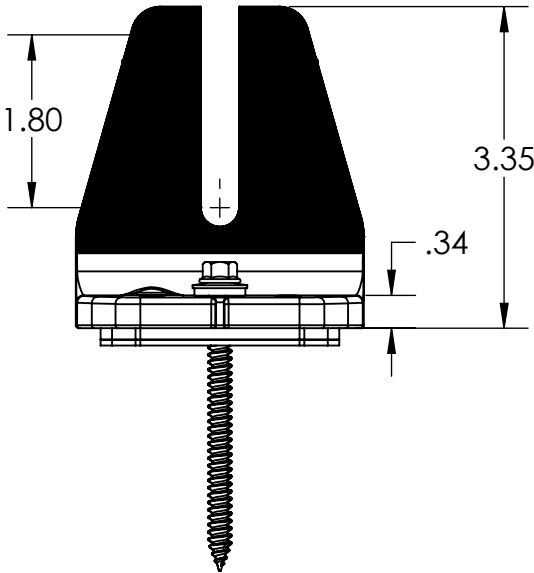
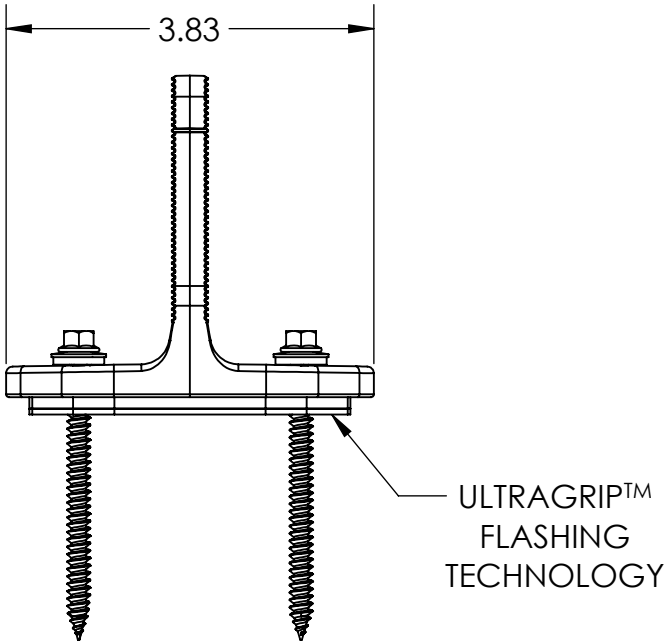
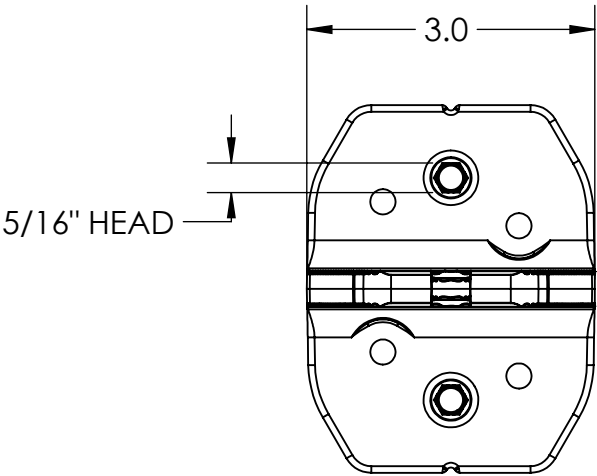
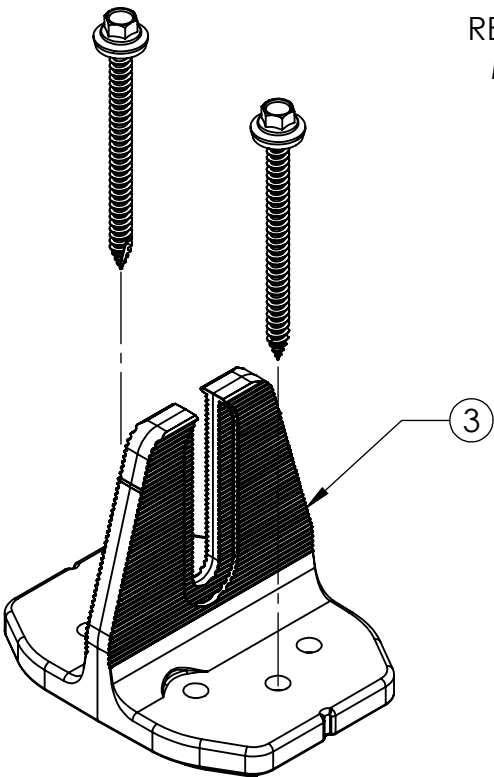
Sincerely,



Matthew Kuzila, PE
Professional Engineer

[Digitally Sealed 9.28.2023](#)

2 RD STRUCTURAL WOOD SCREWS SHOWN FOR REFERENCE. REFER TO HALO ULTRAGRIP™ INSTALLATION MANUAL FOR REQUIRED NUMBER OF FASTENERS FOR RAFTER ATTACHED APPLICATIONS.



ITEM NO.	DESCRIPTION
1	RD STRUCTURAL WOOD SCREW, #14 X 3"
2	EPDM SEALING WASHER, #14 SCREW
3	HALO ULTRAGRIP™ (HUG)

**IRONRIDGE**

ASSY, HALO ULTRAGRIP™,
RAFTER ATTACHED

DWG. NO. EX-0023