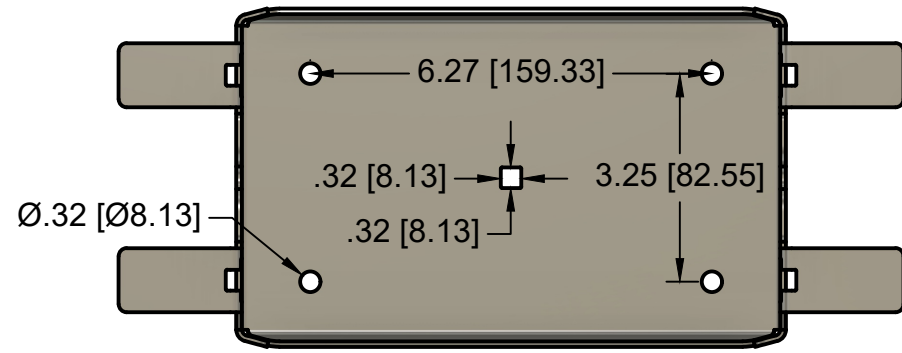


PROJECT			
IntegraRack			
TITLE			
IR-05 Flat Roof Ballast System			
IR-05RF1005			
APPROVED Paul Budge 08/16/2024	SIZE	CODE	DWG NO
CHECKED Paul Budge 08/16/2024	B		
DRAWN Jeff Glouser 08/15/2024	SCALE 1:3	WEIGHT 1lbs 4oz	SHEET 1/1
			REV

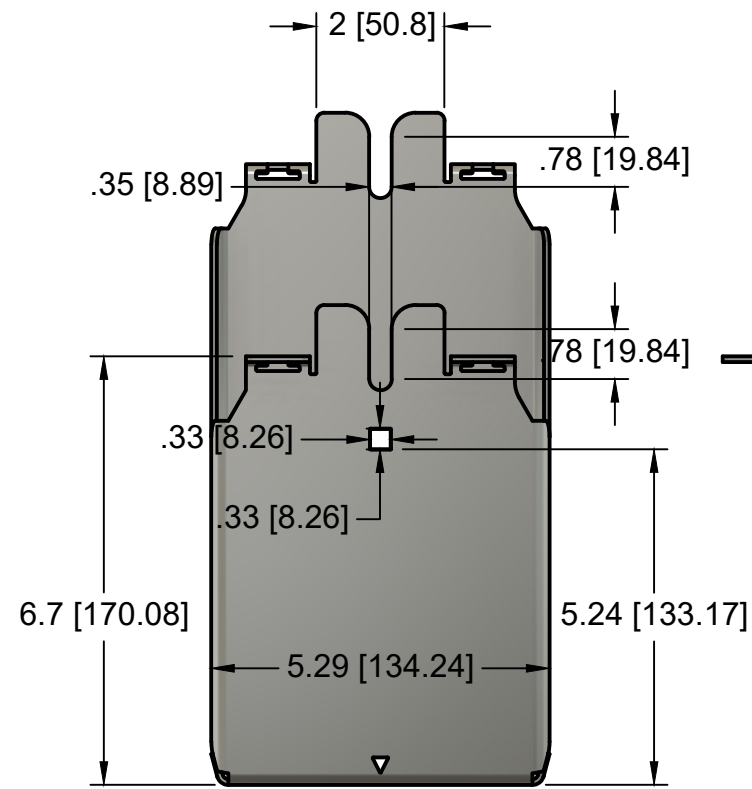
MAXIMUM WIND SPEED (Minimum 32lbs Per Mount)
120 MPH

RAIL-LESS MODULE MOUNT SNOW LOAD RATING (LBS/SQFT)	
MOUNTS PER MODULE	MAXIMUM MODULE SIZE
2	35 SQFT

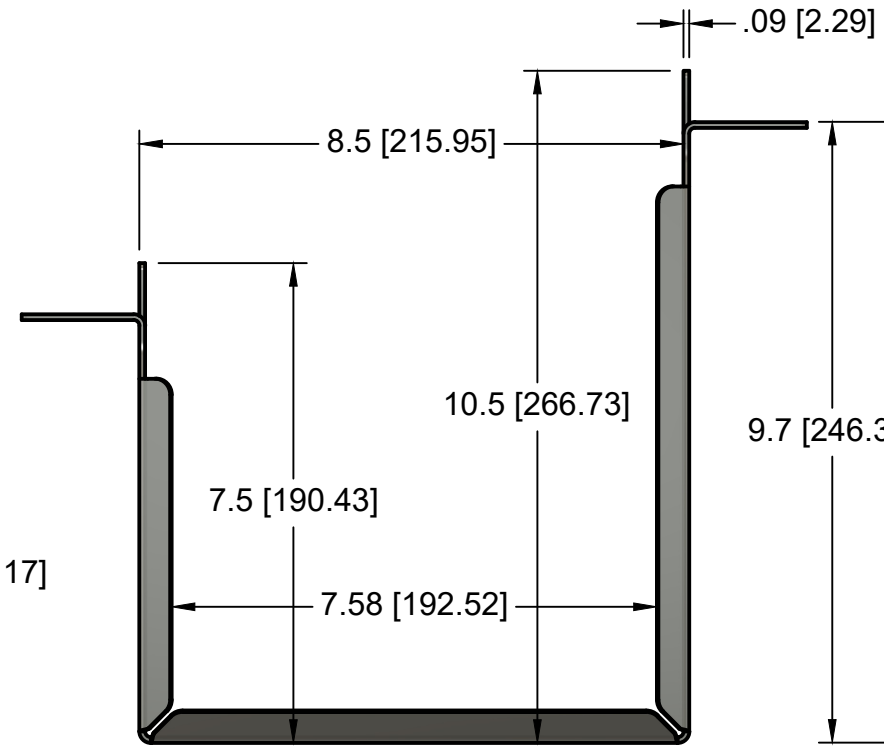
Units in inches and [mm]



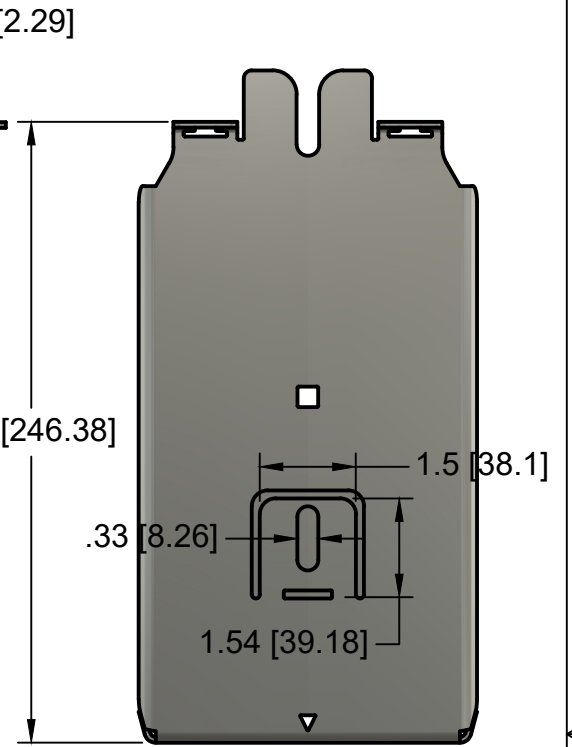
Top View



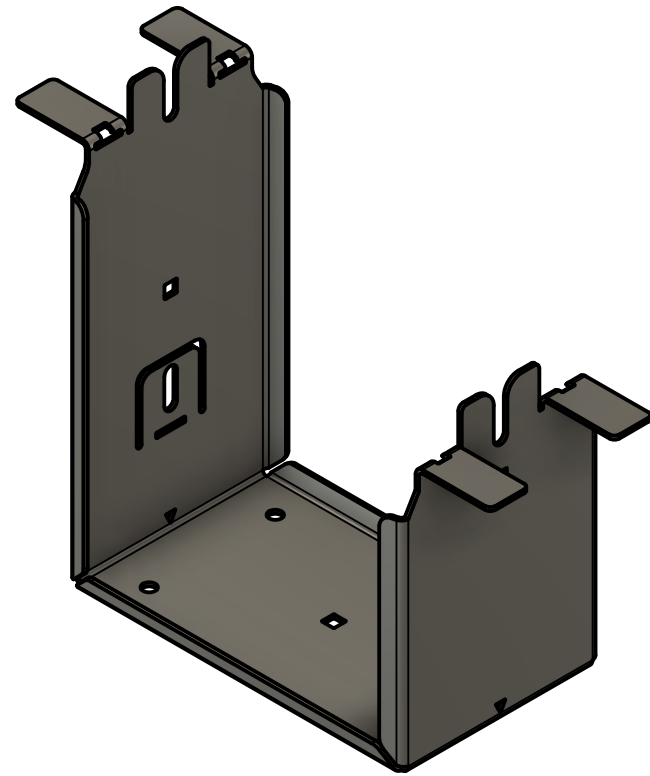
Front View



Side View




Back View



Isometric View

IR-05 BALLAST SYSTEM			
PART NAME	PART NUMBER	DESCRIPTION	MATERIAL
IR-05	IR-05RF1000	Solar module ballasted racking system for flat roof applications.	.090" 5052 Aluminum Mill finish, no coating

	PROJECT IntegraRack			
	TITLE IR-05 - IR-05RF1000			
APPROVED Paul Budge 7/25/2024	SIZE	CODE	DWG NO	REV
CHECKED Paul Budge 7/25/2024	B		0724-003	
DRAWN Jeff Glauser 6/25/2024	SCALE 1:3	WEIGHT	SHEET	



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May 10, 2024
 Mr. Paul Budge
 Diversi-Tech Corp - IntegraRack
 PO Box 910758
 St. George, UT 84791

Subject: Simulated Snow Load and Horizontal Racking Load on IR-05 and IR-F1

Dear Mr. Budge,

Please find included our test reports for the simulated snow load and horizontal slide load on the IR-05 and IR-F1 brackets and bracket clips.

The test specimen composed of solar panels installed to a substrate made from 7/16 in. plywood to simulate a plywood roof. The solar panels were installed using the IR-05 and IR-F1 brackets and clips. For the plywood substrate, 2x4 joists were spaced every two feet on center. A total of three solar panels, measuring 49.5 in. x 83 in., were installed using four brackets and clips. The outer two panels were not attached to the plywood on their outer edges.

A filled water tank weighing 2410 lbf was used to apply the compressive load to the middle solar panel. As the load was being lowered into position the brackets were visually noted to be flexing. The flexing of the brackets caused one rivnut in the cross-member for the IR-F1 bracket to slip out. The total load applied at the moment flexing was noted was 1605 lbf.

SIMULATED SNOW LOAD (COMPRESSIVE LOAD) INSPECTION DETAILS							
NO.	INITIAL			Applied Load (lbf)	AFTER LOAD REMOVAL		
	Panel to Surface Distance (in.)	Initial Bracket Angle	Initial Panel Edge Angle		Panel to Surface Distance (in.)	Final Bracket Angle	Final Panel Edge Angle
1	6.063	0.3°	2.8°	1,605	6.000	2.8°	0.1°
2	10.063	1.8°	5.8°		9.938	0.7°	2.9°
3	9.938	2.0°	4.6°		9.813	2.4°	5.1°
4	6.063	0.6°	1.7°		6.000	0.4°	3.2°

The horizontal racking load test was performed on the same solar panels and brackets that had been used for the simulated snow load compressive force test. A lifting strap was wrapped around the panel lengthwise and run parallel to the solar panel in order to apply a horizontal force to the system. The horizontal force was applied via a skid steer and load was monitored with the digital dynamometer. Initial slide movement was noted at 135 lbf and again at 220 lbf.

HORIZONTAL RACKING FORCE INSPECTION DETAILS				
No.	Initial Measurement from Clip to Edge of Panel (in.)	After 1 st Slide Movement @ ~ 135 lbf: Measurement from Clip to Edge of Panel	After 2 nd Slide Movement @ ~ 220 lbf: Measurement from Clip to Edge of Panel	Observations
1	17.500	19.938	20.438	The previously shifted cross-member from the compressive force test had not been fixed prior to start of the horizontal load test and it came fully apart during the test. This led to shifting of the entire bracket and pullout of one of the screws holding the bracket down (Photos 3-5) at ~ 220 lbf.
2	15.188	16.438	17.625	
3	14.875	14.375	14.625	
4	17.563	15.063	13.500	

Test reports with additional details, photos, and data have been attached.

Respectfully submitted,
PHOENIX NATIONAL LABORATORIES, INC.



Kyle Fleege, P.E.
Project Manager / Mechanical Engineer
Phoenix National Laboratories
Ph: 1.602.431.8887
kyle@pnltest.com
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CLIENT		CLIENT PROJECT REFERENCE		CLIENT ORDER NO.			
IntegraRack		IR-05 & IR-F1 Simulated Plywood Roof - Simulated Snow Load		per S.A.			
SAMPLE DESCRIPTION				TECHNICIANS			
Snow Load Compression Test on Simulated Plywood Roof with IR-05 and IR-F1				Weston A.			
TEST CONDITIONS & EQUIPMENT INFORMATION							
TEMPERATURE:	65 °F ± 10 °F		HUMIDITY:	30% ± 10%			
LOAD TYPE:	Simulated Snow Load - Compression		TEST LOAD:	Record			
EQUIPMENT TYPE:	Dyna-Link 2 Dynamometer MSI-7300RF		EQUIPMENT MODEL:	S/N 100326; CAL 10/13/2023			
WATER TANK WEIGHT:	2410 lbf						
TEST SPECIMEN AND COMPONENT INFORMATION							
TEST SPECIMEN:	IR-05 & IR-F1		ID NO.::	30% ± 10%			
SOLAR PANELS SIZE:	49.5 in. x 83 in.		TEST SPECIMEN AREA:	28.531 ft ²			
LOAD TYPE:	Compression		TEST LOAD:	~2410 lbf			
EQUIPMENT TYPE:	Dyna-Link 2 Dynamometer		EQUIPMENT MODEL:	MSI-7300RF (S/N 100326)			
BRACKET COMPONENT 1:	Flat Roof Ballest System		BRACKET PART NO. 1:	IR-FCBB7500 (IR-05)			
BRACKET COMPONENT 2:	Mounting Bracket		BRACKET PART NO. 2:	IR-FCMH5000 (IR-F1)			
SIMULATED SNOW LOAD (COMPRESSIVE LOAD) TEST PROCEDURE/DESCRIPTION							
Solar panels were installed to a simulated roof made from 7/16 in. plywood using the IR-05 and IR-F1 brackets and bracket clips (Photo 1). A total of 4 brackets and clips were used for the installation. 2x4 joists were every two feet on center. The installed solar panels measured 49.5 in. x 83 in. The test consisted of placing the large water tank directly onto aluminum tubes that were placed along the longitudinal edges of the solar panel to distribute the load across the solar panel (Photo 2). The water tank weight was measured with the dynamometer and recorded as 2410 lbf.							
SIMULATED SNOW LOAD (COMPRESSIVE LOAD) INSPECTION DETAILS							
NO.	INITIAL			Applied Load (lbf)	AFTER LOAD REMOVAL		
	Panel to Surface Distance (in.)	Initial Bracket Angle	Initial Panel Edge Angle		Panel to Surface Distance (in.)	Final Bracket Angle	Final Panel Edge Angle
1	6.063	0.3°	2.8°	1,605	6.000	2.8°	0.1°
2	10.063	1.8°	5.8°		9.938	0.7°	2.9°
3	9.938	2.0°	4.6°		9.813	2.4°	5.1°
4	6.063	0.6°	1.7°		6.000	0.4°	3.2°
OBSERVATIONS							
1605 lbf was briefly applied to the center solar panel on the simulated roof before the weight was unloaded (Photo 4). It was visually noted that the brackets attached to the roof were flexing due to the applied weight being distributed solely to the middle panel, rather than evenly to all the panels, and since the outer panels were not attached to the roof on their outer edge. The flexing of the brackets caused one rivnut in the cross-member for the IR-F1 bracket to slip out (Photo 9).							

TECHNICIAN Weston A.

REVIEWED BY Kyle Hays

CLIENT	CLIENT PROJECT REFERENCE	CLIENT ORDER NO.
IntegraRack	IR-05 & IR-F1 Simulated Plywood Roof - Simulated Snow Load	per S.A.
SAMPLE DESCRIPTION		TECHNICIANS
Snow Load Compression Test on Simulated Plywood Roof with IR-05 and IR-F1		Weston A.

PHOTOS



PHOTO 1: Overview of solar panel test setup



PHOTO 2: Setup with no load and aluminum distribution bars in place



PHOTO 3: Test load being lowered

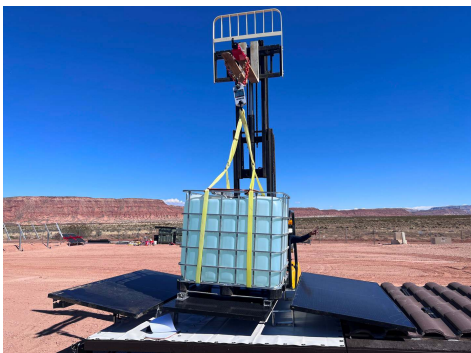


PHOTO 4: Applied load



PHOTO 5: Bracket before load

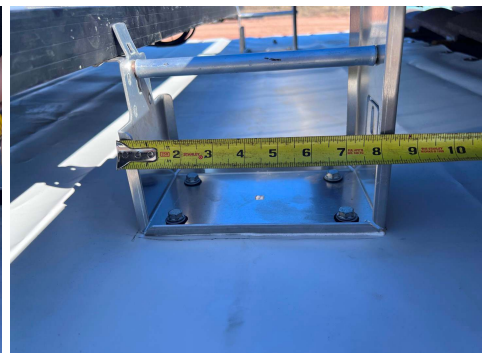


PHOTO 6: Bracket after load



PHOTO 7: Clip before load

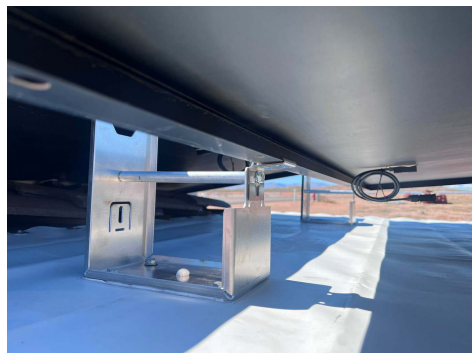


PHOTO 8: Clip after load



PHOTO 9: Rivnut slip / failure



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INSPECTION AND TEST REPORT

PNL REF. # 26-240383 S.O. # 001 INDEX 04
 INSPECTION DATE 03/20/2024
 IR-05 & IR-F1 w/ Simulated Plywood Roof: Horizontal Racking Load

CLIENT		CLIENT PROJECT REFERENCE		CLIENT ORDER NO.
IntegraRack		IR-05 & IR-F1 Simulated Plywood Roof - Side Load		per S.A.
SAMPLE DESCRIPTION				TECHNICIANS
Horizontal Load Slide on Simulated Plywood Roof with IR-05 and IR-F1				Weston A.
TEST CONDITIONS & EQUIPMENT INFORMATION				
TEMPERATURE:	65 °F ± 10 °F	HUMIDITY:	30% ± 10%	
LOAD TYPE:	Horizontal Racking Load	TEST LOAD:	Record	
EQUIPMENT TYPE:	Dyna-Link 2 Dynamometer	EQUIPMENT MODEL:	MSI-7300RF (S/N 100326)	
SKID STEER MODEL:	Kubota SSV65			
TEST SPECIMEN & COMPONENT INFORMATION				
TEMPERATURE:	65 °F ± 10 °F	HUMIDITY:	30% ± 10%	
SOLAR PANELS SIZE:	49.5 in. x 83 in.	TEST SPECIMEN AREA:	28.531 ft ²	
BRACKET COMPONENT 1:	Solar Panel Clip	BRACKET PART NO. 1:	IR-FCBB7500 (IR-05)	
BRACKET COMPONENT 2:	Mounting Bracket	BRACKET PART NO. 2:	IR-FCMH5000 (IR-F1)	
HORIZONTAL RACKING FORCE TEST PROCEDURE/DESCRIPTION				
<p>Solar panels were installed to a simulated roof made from 7/16 in. plywood using the IR-05 and IR-F1 brackets and bracket clips (Photo 1). A total of 4 brackets and clips were used for the installation. 2x4 joists were every two feet on center. The installed solar panels measured 49.5 in. x 83 in. The horizontal load test was performed after completion of the simulated snow load / compressive load test (PNL Report 26-240383.001.01). A lifting strap was wrapped around the panel lengthwise and run parallel to the solar panel to apply a horizontal force to the system (Photo 1). Force was applied using the skid steer and load was monitored with the digital dynamometer. Slide movement was noted at 135 lbf and 220 lbf.</p>				
HORIZONTAL RACKING FORCE INSPECTION DETAILS				
No.	Initial Measurement from Clip to Edge of Panel (in.)	After 1 st Slide Movement @ ~ 135 lbf: Measurement from Clip to Edge of Panel	After 2 nd Slide Movement @ ~ 220 lbf: Measurement from Clip to Edge of Panel	Observations
1	17.500	19.938	20.438	The previously shifted cross-member from the compressive force test had not been fixed prior to start of the horizontal load test and it came fully apart during the test. This led to shifting of the entire bracket and pullout of one of the screws holding the bracket down (Photos 3-5) at ~ 220 lbf.
2	15.188	16.438	17.625	
3	14.875	14.375	14.625	
4	17.563	15.063	13.500	

TECHNICIAN Weston A. [Signature]

REVIEWED BY [Signature]

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INSPECTION AND TEST REPORT

PNL REF. # 26-240383 S.O. # 001 INDEX 04

INSPECTION DATE 03/20/2024

IR-05 & IR-F1 w/ Simulated Plywood Roof: Horizontal Racking Load

CLIENT	CLIENT PROJECT REFERENCE	CLIENT ORDER NO.
IntegraRack	IR-05 & IR-F1 Simulated Plywood Roof - Side Load	per S.A.
SAMPLE DESCRIPTION		TECHNICIANS
Horizontal Load Slide on Simulated Plywood Roof with IR-05 and IR-F1		Weston A.

PHOTOS



PHOTO 1: Test setup



PHOTO 2: Test setup



PHOTO 3: Panel under load



PHOTO 4: After cross-member disengagement



PHOTO 5: After cross-member disengagement



PHOTO 6: After cross-member disengagement