



**CONSULTING STRUCTURAL
AND CIVIL ENGINEERS**

**7408 TEGNER DRIVE
ROSEMEAD, CA 91770**

**PHONE: (626) 376-5351
FAX: (626) 376-5351**

Job	2014.001		date	7.22.2014	by	MC	Sheet	1	of	3
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Subject: Spider Rax Black Widow and Red Widow Roof Mounting System for Pitched Rooftops (California)

STRUCTURAL TESTING AND ANALYSIS (STATIC LOAD RESULTS)

Project: Spider Rax Black Widow and Red Widow Roof Mounting System for Pitched Rooftops (California)
Location: State of California
Client: Spider Rax

Applicable Codes:

2013 California Building Code (Based on the 2012 International Building Code)
ASCE 7-10 Minimum Design Loads for Buildings and Other Structures, by ASCE/SEI, 2010
2012 International Residential Code

Material Specifications for testing

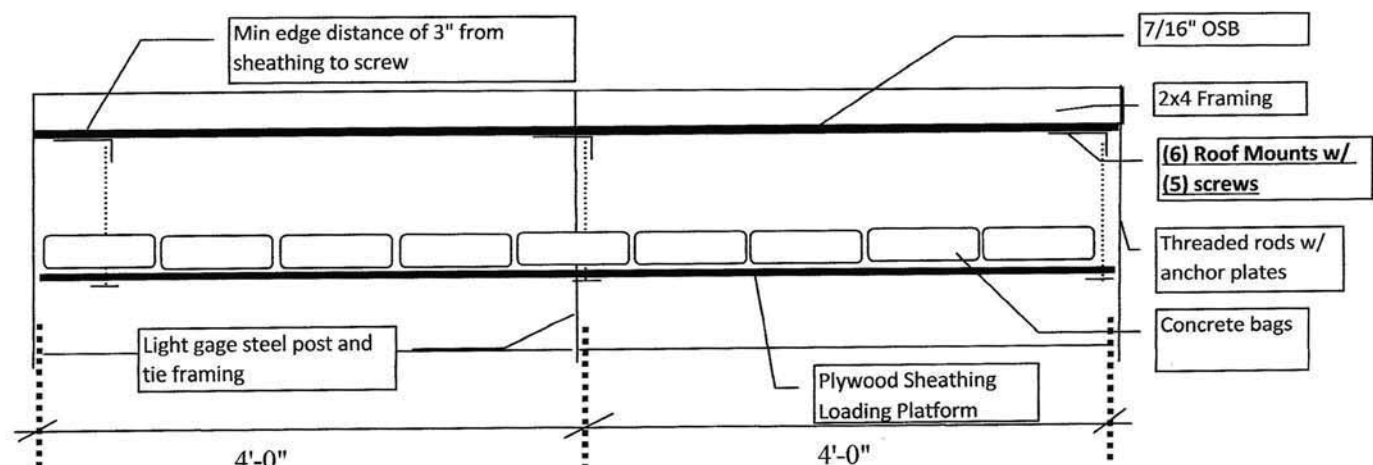
7/16" thick OSB sheathing, 24/16 Panel Index. 4ft wide by 8ft long
Extruded Aluminum (See specifications). Includes bracket (foot/panel mount) and clamp
Kwikseal II Woodbinder #12 x2" screw (5 per mount). See specifications
#14 wood screw to connect 2x4 framing
2x4 Doug Fir-Larch framing
3/8" A307 Threaded rod, nut and washer
5/8" thick Plywood sheathing
Light gage steel framing (Posts, ties and clips)
90 lbs concrete mix bags (19 total)

Test Objectives

Roof mounts tested to verify capacity (and factor of safety) against pull out and lateral shear forces, as well as deflections.

Test setup (Pull out forces)

2x4 doug fir framing is attached to light gage steel framing. OSB Sheathing is attached to 2x4 doug fir framing
Mounts are attached to OSB sheathing with WoodBinder Kwikseal II #12 screws, 3in min from edge of OSB
Threaded rod is connected to roof mount and attached to plywood sheathing loading platform

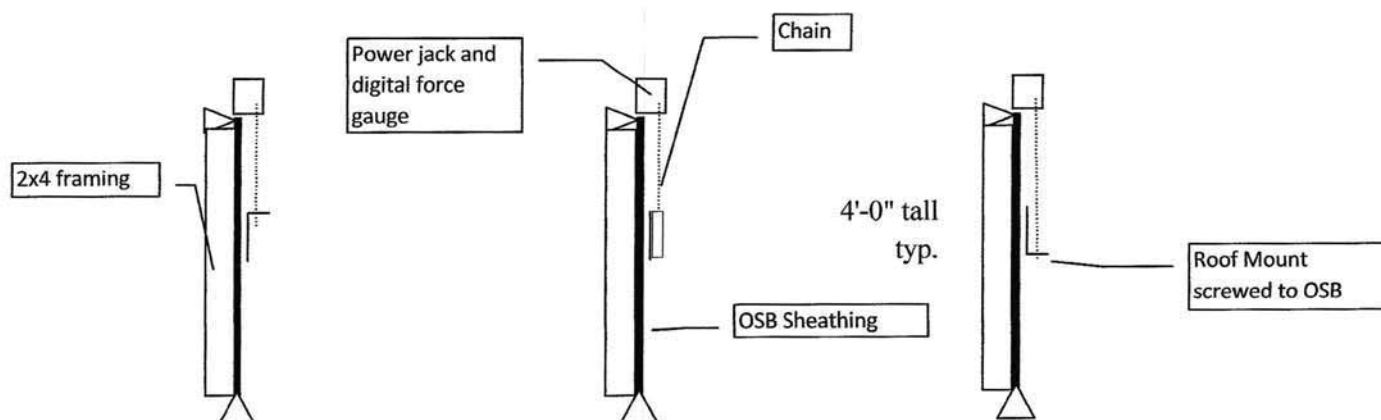


Subject: Spider Rax Black Widow and Red Widow Roof Mounting System for Pitched Rooftops (California)

Design Assumptions

- 13 Analysis of the mount is based upon the maximum effects of either the largest gravity loads or wind uplift loads. The point loads (either positive or negative) can act in either direction depending on the type of loading (i.e. wind, snow... etc)
- 14 Modules may be installed in landscape or portrait orientation
- 15 Modules may have maximum dimensions of 39" in width and 77" in length
- 16 Terrain Topographic factor $K_{zt} = 1.0$

*Omega Square Engineering has reviewed the Spider Rax Black and Red Widow Roof Mounting system with **testing data and analytical procedures**, and certifies that the roof mounts, as specified above in the design assumptions, can withstand a wind pressure equivalent to a wind speed (strenght level) of approximately **120mph****. The mounting fasteners performed as expected against axial and shear forces in the OSB.*



Test procedure and results (Lateral Shear forces per individual mount)

East test setup configuration was loaded at a rate of 100 lbs/min with a hydraulic jack and verified with a digital force gauge. The average shear load was 1191 lbs. per mount.

Design Assumptions and conclusions

- 1 Basic Wind Speed for Risk Category II per ASCE 7-10 (Strength level, excluding Special Wind Regions)
- 2 Maximum mean roof height of no more than 30'-0" as defined by ASCE 7-10
- 3 Exposure Category B, C or D as defined by ASCE 7-10
- 4 Dry service conditions (proper water proofing to be installed)
- 5 Roof sheathing minimum thickness of 7/16" OSB. Panel Index 24/16, with rafters spaced at 16" o.c. max.
- 6 Four PV mounts per PV module, such that adjacent modules share two PV mounts
- 7 Array may be located within zones 1, 2 for hip or gable roofs with a min pitch of 7° to a maximum pitch of 45°
- 8 *Snow load of no more than 20 lbs/ft²
- 9 Fasteners installed per manufactured specifications
- 10 **(5) fasteners per mount**
- 11 Structure is considered an enclosed building



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Sincerely

Manuel Chan, PE SE



This engineering report verifies that Omega Square Engineering has provided independent observation for loads testing as described in this report. The results of this load test reflect actual deflection values and are generally accepted as the industry standard for testing module mounting systems. Omega Square Engineering does not field check installations or verify that the mounting system is installed as described in this engineering report.

Omega Square Engineering does not express an opinion as to the load bearing characteristics of the structure the mounting system/modules are being installed on.

Installer shall verify proper flashing and/or protection to weather of the roof mount after installation. Omega Square Engineering does not express an opinion of the after installation conditions of the equipment.

* Based on minimum provisions on ASCE 7-10, Chapter 7. (Case Study areas are not considered)

** As described on Figure 26.5-1A of the ASCE7-10 Standard for Min. Design Loads for Buildings & other Structures
Values are nominal design 3-second gust wind speed in miles per hour

Attachments:

- 1 Related ASCE 7-10 tables and figures
- 2 Black and Red Widow Roof Mount specifications
- 3 Kwikseal II Wood Binder fastener specifications

ASCE 7-10 TABLES

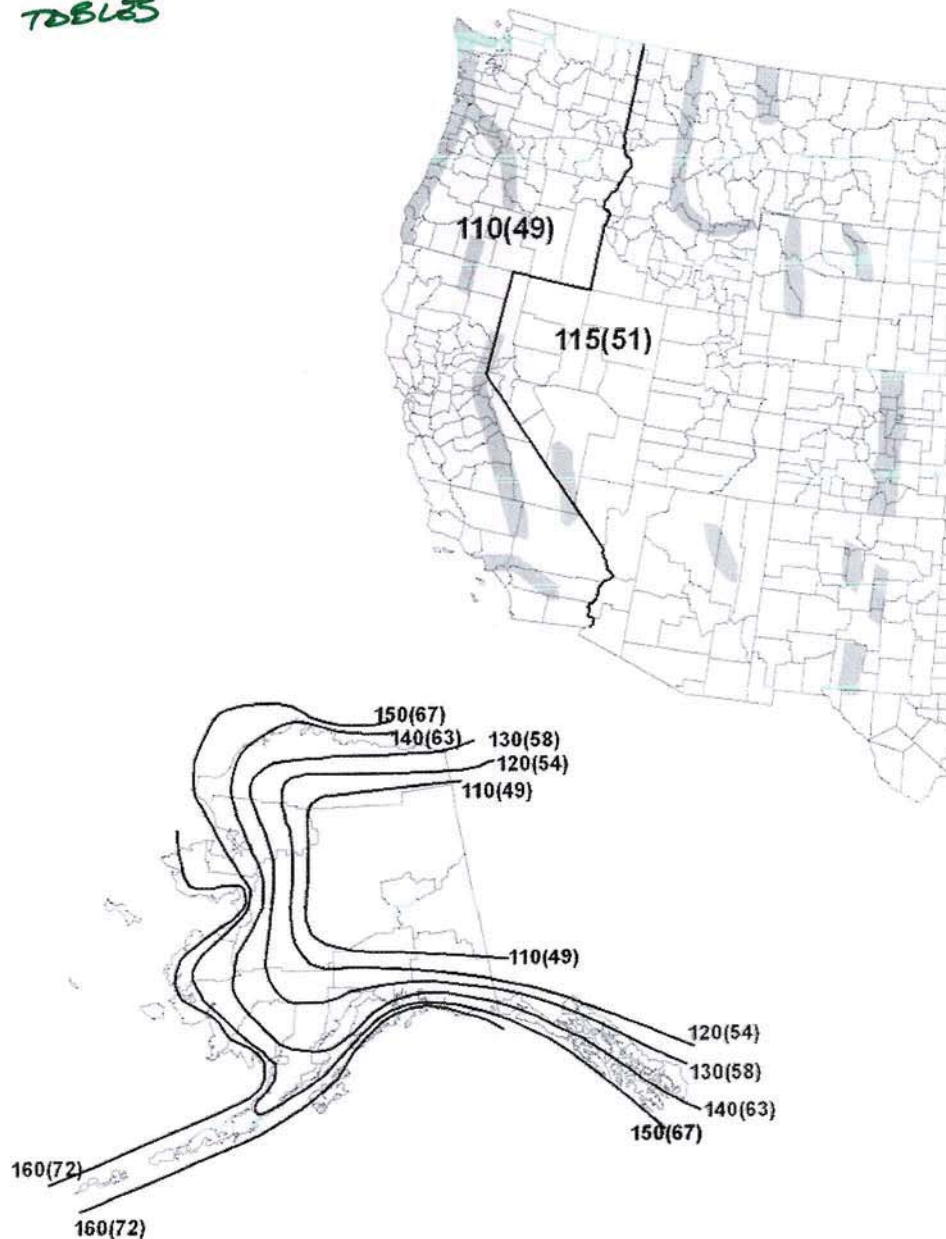
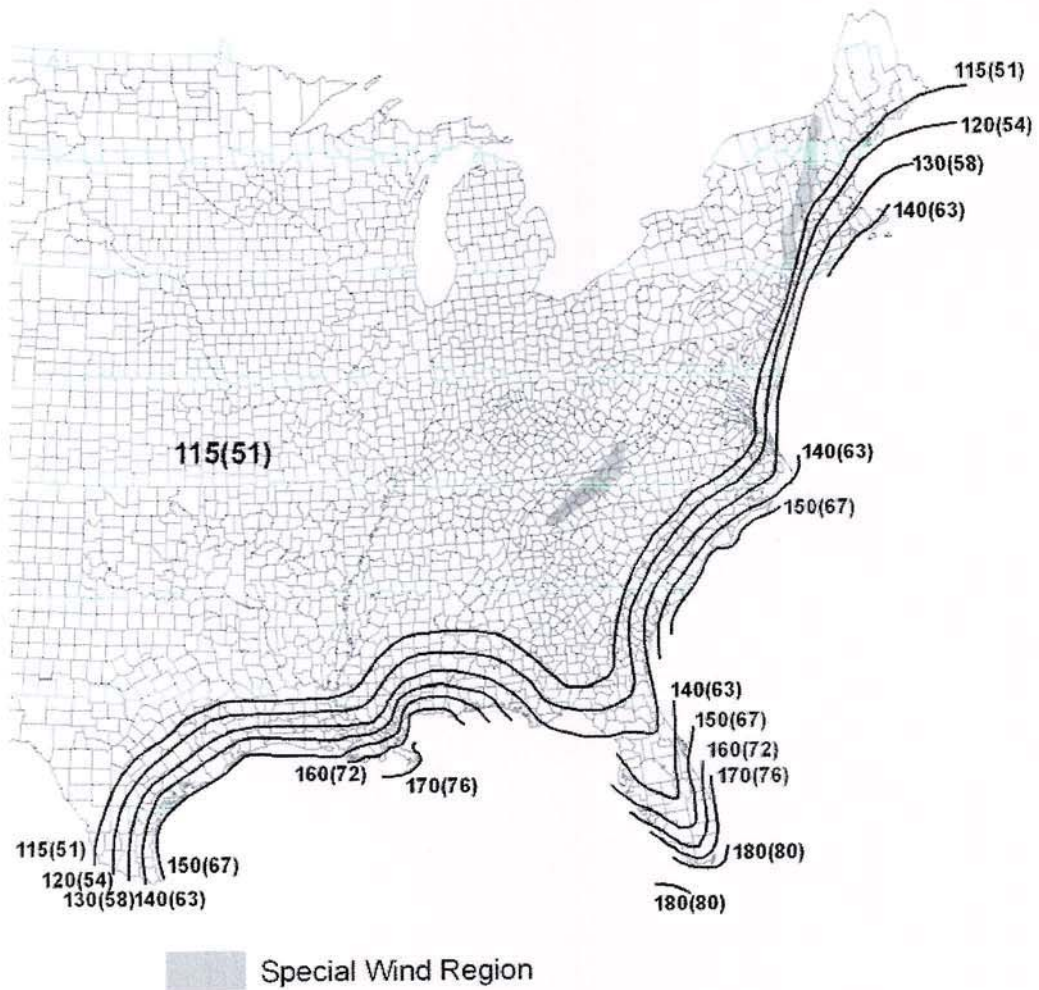


Figure 26.5-1A Basic Wind Speeds for Occupancy Category II Buildings and Other Structures.

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

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Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii – Special Wind Region Statewide	130	(58)

150(67) 160(72)
170(76)

Puerto Rico

Figure 26.5-1A (Continued)

Wind Directionality Factor, K_d **Table 26.6-1**

Structure Type	Directionality Factor K_d^*
Buildings	
Main Wind Force Resisting System	0.85
Components and Cladding	0.85
Arched Roofs	0.85
Chimneys, Tanks, and Similar Structures	
Square	0.90
Hexagonal	0.95
Round	0.95
Solid Freestanding Walls and Solid Freestanding and Attached Signs	0.85
Open Signs and Lattice Framework	0.85
Trussed Towers	
Triangular, square, rectangular	0.85
All other cross sections	0.95

*Directionality Factor K_d has been calibrated with combinations of loads specified in Chapter 2. This factor shall only be applied when used in conjunction with load combinations specified in Sections 2.3 and 2.4.

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Main Wind Force Resisting System and Components and Cladding		All Heights
Table 26.11-1	Internal Pressure Coefficient, (GC_{pi})	Walls & Roofs
Enclosed, Partially Enclosed, and Open Buildings		

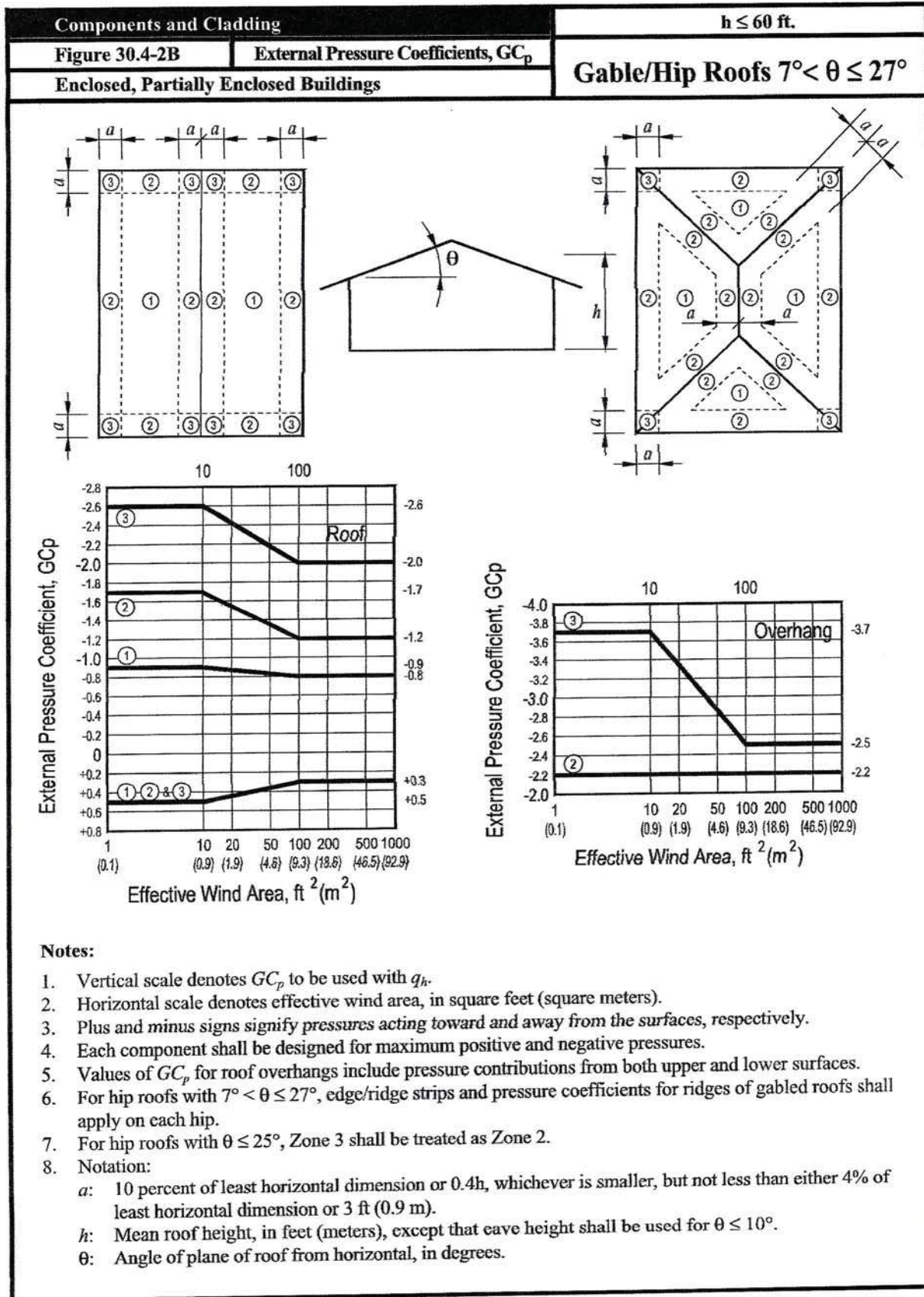
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Main Wind Force Resisting System – Part 1		All Heights		
Velocity Pressure Exposure Coefficients, K_h and K_z				
Table 27.3-1				
Height above ground level, z		Exposure		
ft	(m)	B	C	D
0-15	(0-4.6)	0.57	0.85	1.03
20	(6.1)	0.62	0.90	1.08
25	(7.6)	0.66	0.94	1.12
30	(9.1)	0.70	0.98	1.16
40	(12.2)	0.76	1.04	1.22
50	(15.2)	0.81	1.09	1.27
60	(18)	0.85	1.13	1.31
70	(21.3)	0.89	1.17	1.34
80	(24.4)	0.93	1.21	1.38
90	(27.4)	0.96	1.24	1.40
100	(30.5)	0.99	1.26	1.43
120	(36.6)	1.04	1.31	1.48
140	(42.7)	1.09	1.36	1.52
160	(48.8)	1.13	1.39	1.55
180	(54.9)	1.17	1.43	1.58
200	(61.0)	1.20	1.46	1.61
250	(76.2)	1.28	1.53	1.68
300	(91.4)	1.35	1.59	1.73
350	(106.7)	1.41	1.64	1.78
400	(121.9)	1.47	1.69	1.82
450	(137.2)	1.52	1.73	1.86
500	(152.4)	1.56	1.77	1.89

Notes:

- The velocity pressure exposure coefficient K_z may be determined from the following formula:
 For $15 \text{ ft.} \leq z \leq z_g$ For $z < 15 \text{ ft.}$
 $K_z = 2.01 (z/z_g)^{2/\alpha}$ $K_z = 2.01 (15/z_g)^{2/\alpha}$
- α and z_g are tabulated in Table 26.9.1.
- Linear interpolation for intermediate values of height z is acceptable.
- Exposure categories are defined in Section 26.7.

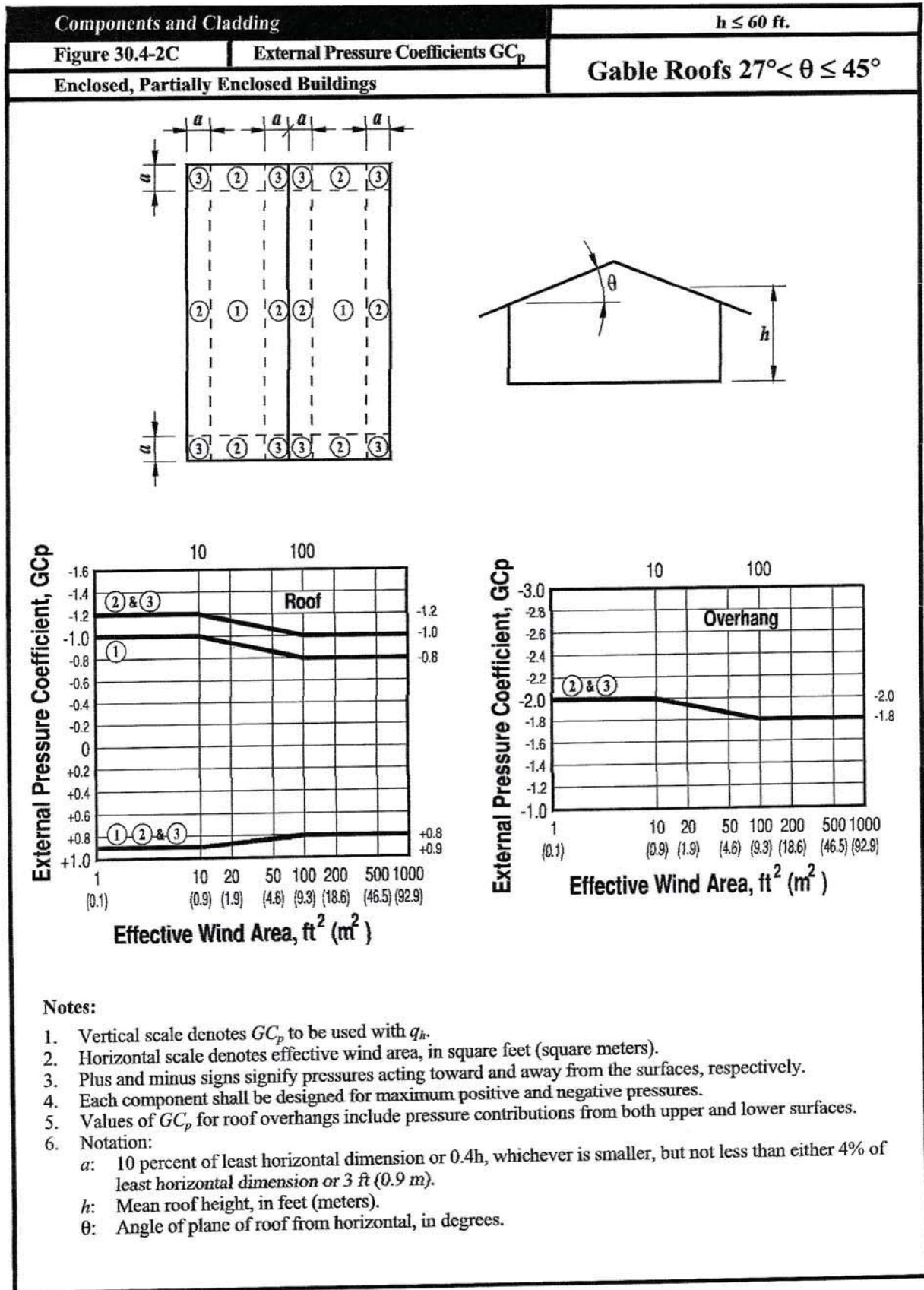
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Notes:

1. Vertical scale denotes GC_p to be used with q_h .
2. Horizontal scale denotes effective wind area, in square feet (square meters).
3. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
4. Each component shall be designed for maximum positive and negative pressures.
5. Values of GC_p for roof overhangs include pressure contributions from both upper and lower surfaces.
6. For hip roofs with $7^\circ < \theta \leq 27^\circ$, edge/ridge strips and pressure coefficients for ridges of gabled roofs shall apply on each hip.
7. For hip roofs with $\theta \leq 25^\circ$, Zone 3 shall be treated as Zone 2.
8. Notation:
 - a : 10 percent of least horizontal dimension or $0.4h$, whichever is smaller, but not less than either 4% of least horizontal dimension or 3 ft (0.9 m).
 - h : Mean roof height, in feet (meters), except that eave height shall be used for $\theta \leq 10^\circ$.
 - θ : Angle of plane of roof from horizontal, in degrees.

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Features and Benefits

- Fastener is designed to attach steel roofing & siding used in post-frame & residential metal roofing applications.
- Threads transition from fine to coarse to generate superior holding strength in various wood substrates.
- Sharp Point & pronounced lead thread consistently drills high tensile 29 & 26 gauge steel with no "point walking."
- Type 17 point reduces metal shavings that can embed themselves in the rubber washer.
- EPDM rubber is vulcanized to a galvanized steel washer to form an excellent seal even when driven at an angle.

SIZE	CARTON QTY.	WEIGHT/M
10 x 1"	3000	7.8
10 x 1 1/2"	2500	9.9
10 x 2"	2000	12.2
10 x 2 1/2"	1500	14.3
10 x 3"	1000	17.2
12 x 3/4" Stitch	2500	8.8

NOTES: All strength values shown below are ultimate values, expressed in LBS. Apply an appropriate safety factor to obtain design limits.

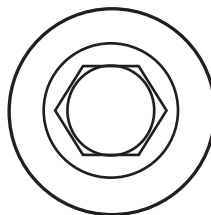
PULL OUT STRENGTH LBS. ULT.		
SUBSTRATE	PENETRATION	VALUE
3/4" PLY		707
5/8" PLY		590
1/2" PLY		400
7/16" OSB		310
2 X Y. PINE*	1"	1052
2 X Y. PINE*	FULL	1552
2 X SPF*	1"	492
2 X SPF*	FULL	1042
2 X OAK	1"	1894

* Y.PINE (Yellow Pine) * SPF (Spruce Pine Fir)

PULL OVER STRENGTH LBS. ULT.			
SUBSTRATE	GAUGE	THICKNESS	VALUE
AZ55 Galvalume	29	.015	378
AZ55 Galvalume	26	.019	629
AZ55 Galvalume	24	.024	721

FOR PROPER APPLICATION, THE USE OF IMPACT DRIVERS ARE NOT RECOMMENDED FOR POWDER COATED OR ANY WET PAINTED FASTENER

KWIKSEAL I WoodBinder®



POWDER COATED

HEAD STYLE

1/4" HWH

POINT DIAMETER

30° Sharp Point Type 17

MAJOR DIAMETER

.210/.200

MINOR DIAMETER

.130/.126

BONDED WASHER DIAMETER

.472

HEAD ACROSS FLATS

.247/.244

ULT. TENSILE STRENGTH

1904 LBS.

MIN. TORSIONAL STRENGTH

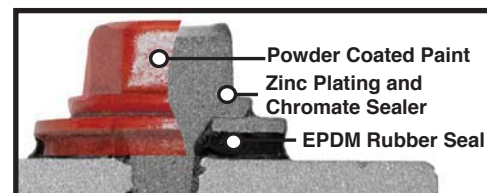
60 IN-LBS.

NOM. SHEAR STRENGTH

1547 LBS.



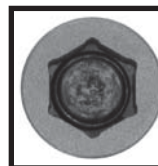
Sharp Point
Type 17



Hex Washer Head with EPDM rubber washer provides a watertight seal on roof applications. Sealtite sockets are designed to allow for the added thickness of the powder coat.

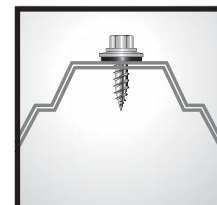
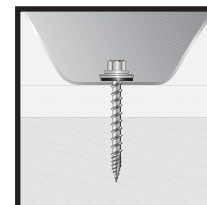


The combination of the Type 17 point & transition thread from fine to coarse generates superior drill speed in metal & holding strength in wood substrates.



ST Magnetic Sockets are available for powder coated fasteners.

APPLICATIONS





HelioLug

Amphenol Industrial Solar Technologies (AIST) offers products and solutions for all segments of the solar electric system. AIST understands the need for efficient (low loss) power transfer, highly reliable, and cost effective solutions that are required to be competitive in this industry. We can provide panel manufacturers, installers, and OEM's with connectivity products for both thin film and crystalline silicon technologies. Amphenol® has a broad range of technologies to help minimize the cost of inverters and power conditioners. Amphenol® Industrial Solar Technologies can help you power the planet with the sun.

The HelioLug is a grounding component for solar modules and solar racking systems allowing easy termination to the ground wire.

The HelioLug has a versatile enough design it can be used for commercial or utility scale installations as well as residential installations. It is UL 2703 certified for use with a ground wire, eliminating potential code compliance surprises. The HelioLug comes with all the certified custom hardware needed for making rapid, secure connections to PV modules and racks.

The HelioLug is just one of the solar solutions Amphenol® Industrial Solar Technologies has to offer.

Features:

- UL 2703 certified grounding lug
- Meets all NEC 2008/2011 requirements
- Quick and easy installation
- For use with virtually all module frames and racks, (0.09 inches (2 mm) to 0.25' (6.35 mm) thick)
- Capable of accepting 4-12 AWG solid copper conductors
- Code compliant "first make - last break" grounding system
- Compatible with all module grounding holes, (0.16" (4mm) to 0.295" (7.5mm))
- Certified reusable hardware for servicing without replacement



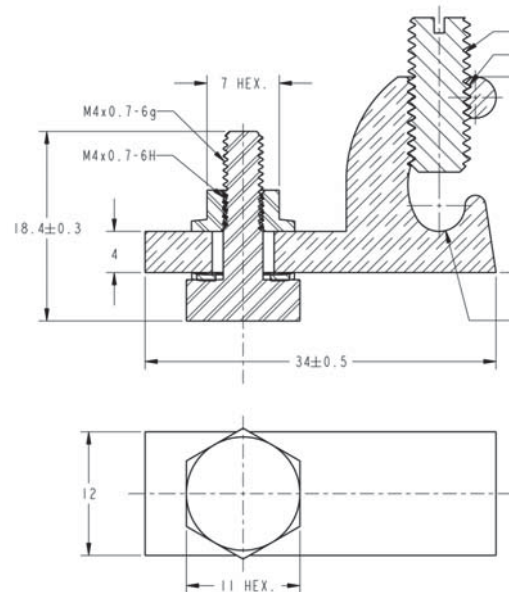
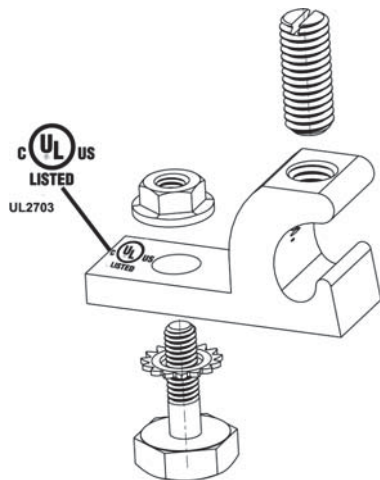
HelioLug

UL 2703 E338690

QIMS7 (Canada) E338690

Included Components:

- 1) Lay in lug (tin-plated, solid copper lay-in lug with a stainless-steel set screw)
- 2) Stainless star washer
- 3) Stainless steel bolt
- 4) Stainless serrated lock nut



How to order

1		2		3		4	
HG		L		U		I	
Product Line		Product Type		Approvals		Packaging	
HG	Helios Grounding Products	L	HelioLug (Wire Range 4-12 AWG)	U	UL	I	Individual
						M	1000 pcs

INSTALLATION INSTRUCTIONS:

- Place the lug to the designated module grounding hole with the star washer between the grounding lug and the module frame in order to break through the anodizing and establish electrical contact with the aluminum. Torque the bolt and nut to 30 in-lbs. NOTE: These instructions provide guidelines for general use. If available, the specific module manufacturer's instructions for the location of the star washer are to be followed.
- For the attachment to the racking, slide the bolt into the mounting channel of the extrusion or into a 1/4" hole drilled through the extrusion. Place the star washer between the racking and lug and secure the nut and bolt to 30 in-lbs. NOTE:
- Insert a 4 to 12 AWG copper wire into the lug and tighten the lug set screw to the copper wire to the torque based on the wire size. (4-6 AWG at 35 in-lbs and 8-12 AWG at 30 in-lbs). Do not exceed the maximum rated overcurrent protection, 20 A (12 AWG), 40 A (10 AWG), 90 A (8 AWG), 150 A (6 AWG), and 200 A (4 AWG).

Notice: Specifications are subject to change without notice. Contact your nearest Amphenol Corporation Sales Office for the latest specifications. All statements, information and data given herein are believed to be accurate and reliable but are presented without guarantee, warranty, or responsibility of any kind, expressed or implied. Statements of suggestions concerning possible use of our products are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe any patent. The user should assume that all safety measures are indicated or that other measures may not be required. Specifications are typical and may not apply to all connectors.

For further information on your individual application requirements, contact: Amphenol Corporation

North America:
Amphenol Industrial Operations
180 N. Freeport Drive, Plant 4
Nogales, AZ 85621
Tel: (520) 285-5130
Fax: (520) 285-5134

Email: rpedrazzini@amphenol-aio.com

Europe:
Amphenol Industrial Operations Europe
Via Barbaiana 5
I-20020 Lainate (MI) Italy
Tel: +39 02 93254.204
Fax: +39 02 93254.444

Email: info@amphenol-aio.com

Middle East:
Amphenol Middle East Enterprises FZE
Postal: PO Box 21107, Aiman Free Zone - UAE
Physical: Warehouse #C1-16, Aiman Free Zone - UAE
Phone: +9 716-7422494

Fax: +9 716-7422941

Asia:
Amphenol Technology Shenzhen Ltd
Block 5 Fuan 2nd Industrial Park
Dayang Rd, Fuyong Baoan
Baoan, Shenzhen, China 518103
Tel: +86 755 2881 8389
Fax: +86 755 2991 8310
Email: enquiry@amphenol-aio.com