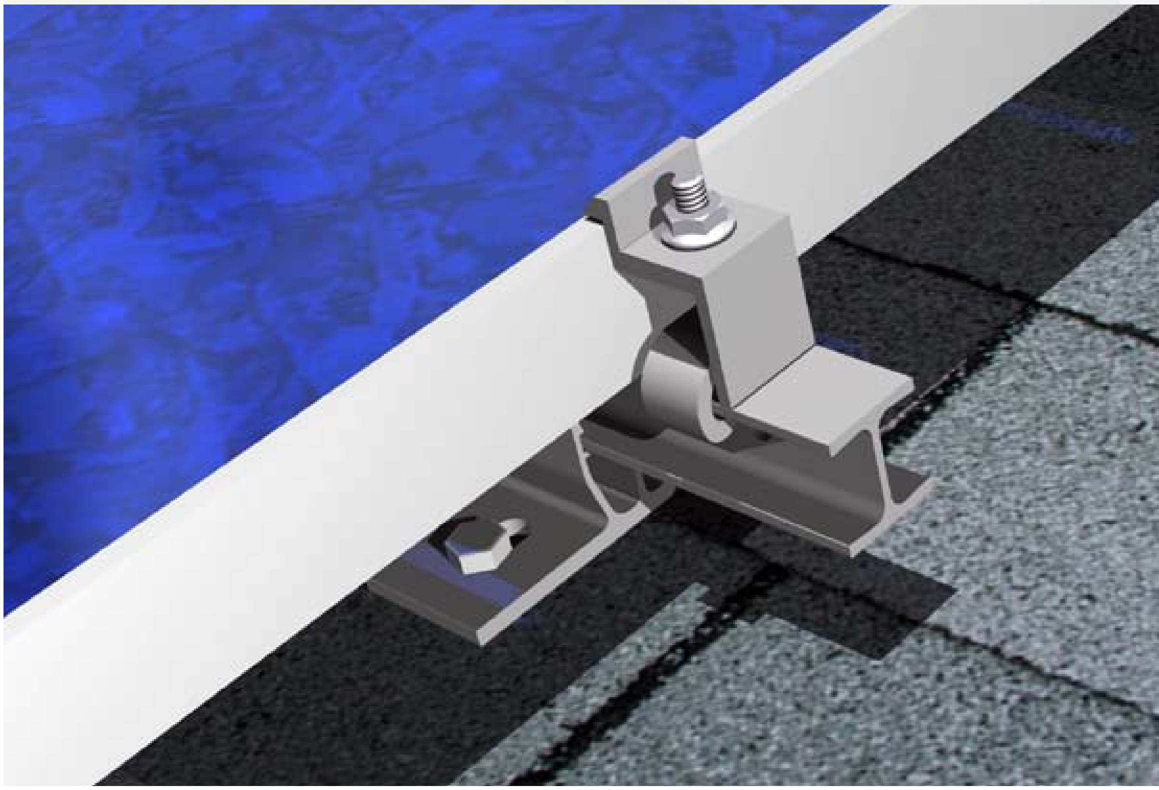
CLICKSYS™

Code-Compliant Installation Manual 670

Patents pending.



Unirac Code-Compliant Installation Manual

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UNIRAC®

Bright Thinking in Solar

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i. Installer's Responsibilities

Please review this manual thoroughly before installing your CLICKSYS™.

This manual provides (1) supporting documentation for building permit applications relating to Unirac's CLICKSYS™ PV Module Mounting system, and (2) planning and assembly instructions for CLICKSYS™.

CLICKSYS™ products, when installed in accordance with this bulletin, will be structurally adequate and will meet the structural requirements of the IBC 2006, IBC 2003, ASCE 7-02, ASCE 7-05 and California Building Code 2007 (collectively referred to as "The Code"). Unirac also provides a limited warranty on CLICKSYS™ products (page 20).

CLICKSYS™ is a system of engineered components with an optimized strength to weight ratio. With CLICKSYS™, you'll attach flush mount roof arrays with innovative and simplified attachments, providing speed of installation.

CLICKSYS™ is also a system of technical support: complete installation and code compliance documentation, person-to-person customer service, leading-edge mobile support and design assistance to help you solve the toughest challenges.

The installer is solely responsible for:

- Complying with all applicable local or national building codes, including any that may supersede this manual;
- Ensuring that Unirac and other products are appropriate for the particular installation and the installation environment;
- Ensuring that the roof, its rafters, connections, and other structural support members can support the array under all code level loading conditions (this total building assembly is referred to as the building structure);
- Using only Unirac parts and installer-supplied parts as specified by Unirac (substitution of parts may void the warranty and invalidate the letters of certification in all Unirac publications);
- Ensuring that all installed fasteners have adequate pullout strength and shear capacities;
- Verifying the strength of any fastener used to attach CLICKSYS™ components to a roof;
- Maintaining the waterproof integrity of the roof, including selection of appropriate flashing and sealing material;
- Ensuring safe installation of all electrical aspects of the PV array; and
- Ensuring correct and appropriate design parameters are used in determining the design loading used for design of the specific installation. Parameters, such as snow loading, wind speed, exposure and topographic factor should be confirmed with the local building official or a licensed professional engineer.

Part I. Installing CLICKSYS™

INTRODUCTION

The Unirac Code-Compliant Installation Instructions support applications for building permits for photovoltaic arrays using CLICKSYS™, Unirac's PV module mounting system.

This manual, CLICKSYS™ Code Compliant Installation Manual, governs installations using CLICKSYS™. Unirac Inc. makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

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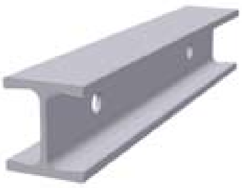
CLICKSYS™ is a registered trademark of Unirac Inc. in the United States of America and other countries.

BEFORE YOU BEGIN

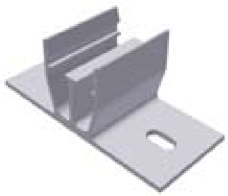
1 Verify that all of the components are included and consistent with your order.

2 To avoid conflicts, never modify or combine CLICKSYS™ with components that are not made for CLICKSYS™. Doing so will void any warranty associated with CLICKSYS™.

COMPONENTS



Beam (144")

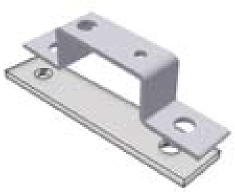


2 Flange Connection *

Shown without butyl option
(2) #14–13 X 3" Concealor™ screws

1 Flange Connection

(1) Lag screw
(1) Washer



Beam Splice **

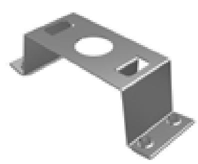
Shown without grounding option
(2) Stainless steel hex bolt
(2) Nut

Mid Clamp

(1) Stainless steel hex bolt
(1) Nut
(1) Slider

End Clamp

(1) Stainless steel hex bolt
(1) Nut
(1) Slider



UGC-2 Grounding

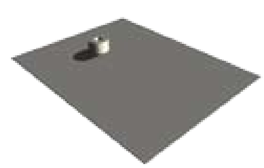
OPTIONAL ATTACHMENTS

2-Piece Aluminum Standoff

(2) 5/16 x 3-1/2" Zinc Plated Lag Bolt
(1) 1 Flange Connection
(1) 3/8" x 3/4" Hex Head Bolt
(1) 3/8" x 1-3/4" EPDM Washer

PV Quick Mount

(1) 5/16" x 3-1/2" Stainless Steel Lag Bolt
(1) 5/16" Sealing Washer
(1) 5/16" EPDM Washer
(1) 1 Flange Connection



CreoTecc Tile Hook (Top)

(2) 5/16" x 3-1/2" Zinc Plated Lag Bolt
(1) 3/8-16 x 3/4" Hex Head Bolt
(1) 3/8" Hex Head Nut

ADDITIONAL COMPONENTS

* Butyl (optional with 2 Flange Connection)

** WEEB 9.5 Grounding (optional with Splice Kit)

PLANNING YOUR CLICKSYS™ INSTALLATION

The installation can be laid out with beams parallel to the rafters or perpendicular to the rafters. Note that CLICKSYS™ beams make excellent straight edges for doing layouts.

Center the installation area over the structural members as much as possible.

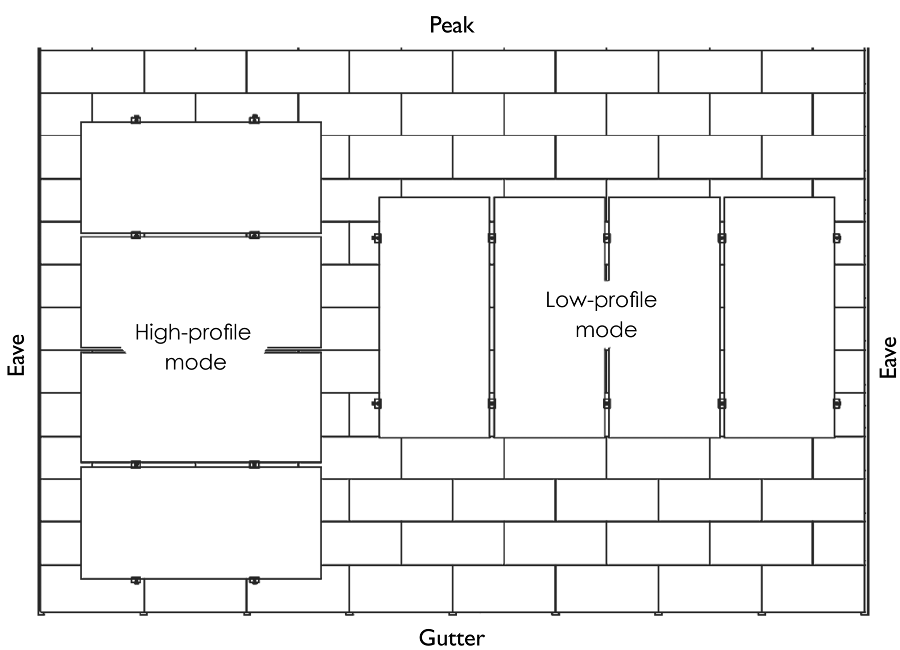
Leave enough room to safely move around the array during installation. Some building codes require minimum clearances around such installations, and the user should be directed to also check 'The Code'.

The width of the installation area equals the length of one module.

The length of the installation area is equal to:

- the total width of the modules,
- plus 1 inch for each space between modules (for mid-clamp),
- plus 3 inches (1½ inches for each pair of end clamps).

To speed installation, mark beam at approximate proper foot space before clicking connections to beam.

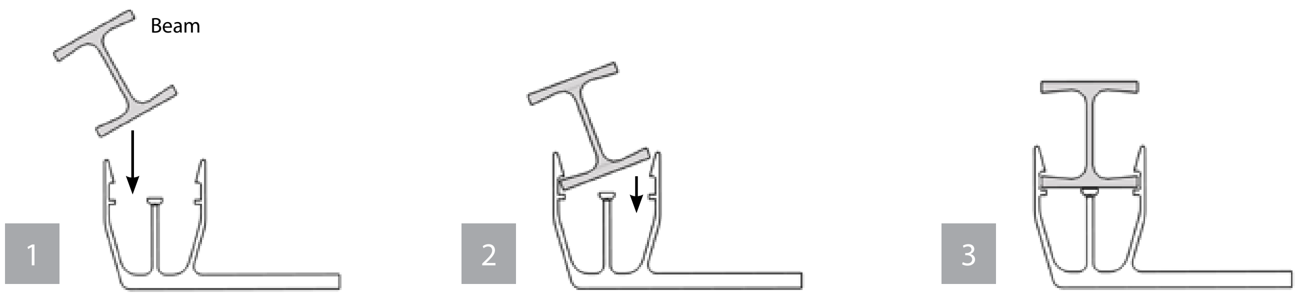


NOTE: Most installations do not overhang on attachment more than 18" of beam.

INSTALLING CLICKSYS™

Step 1: Attach beam to 2 Flange Connection or 1 Flange Connection

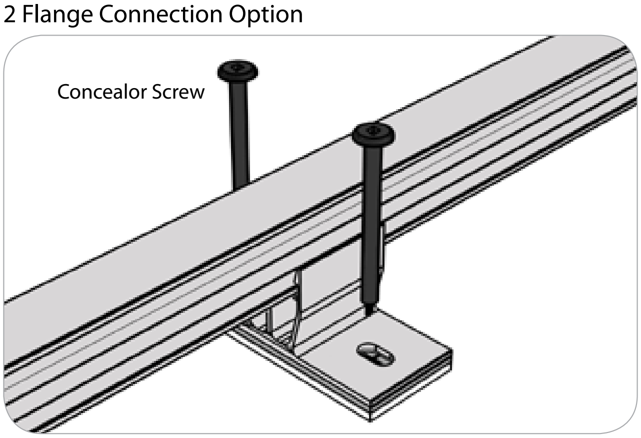
NOTE: Always engage one side before clicking connection into beam.
NOTE: Do not use connection if the engagement features on the connection are bent or damaged.



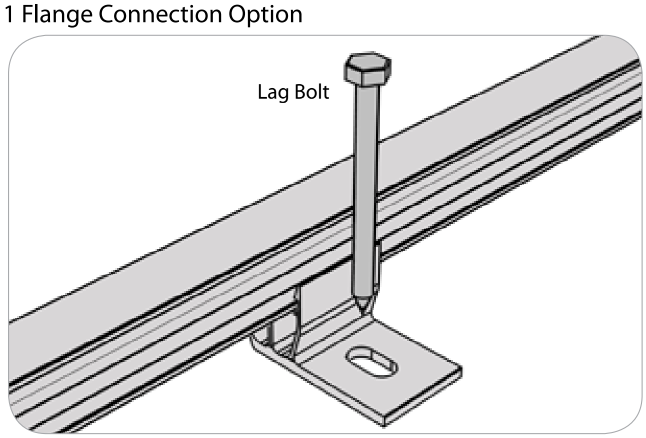
Step 2: Attach 2 Flange Connection or 1 Flange Connection to rafter

NOTE: When using 2 Flange Connection w/Butyl Pad, remove sticker before installing screws.

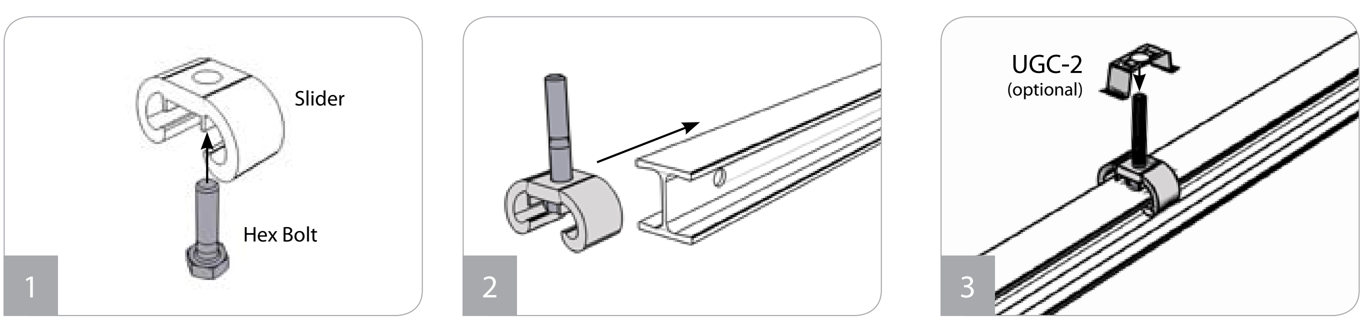
2 Flange Connection Option



1 Flange Connection Option



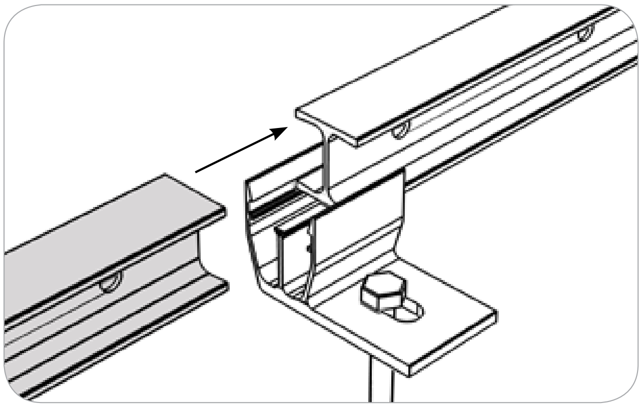
Step 3: Install number of sliders and optional UGC-2 grounding clips

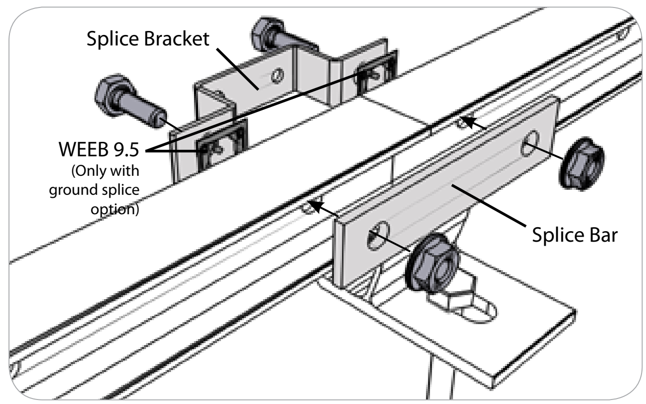


Step 4A: Install Seismic Splices

Option 1 - Use when splicing two beams at a connection

NOTE: Tighten nut to 75 inch pounds without anti-seize.

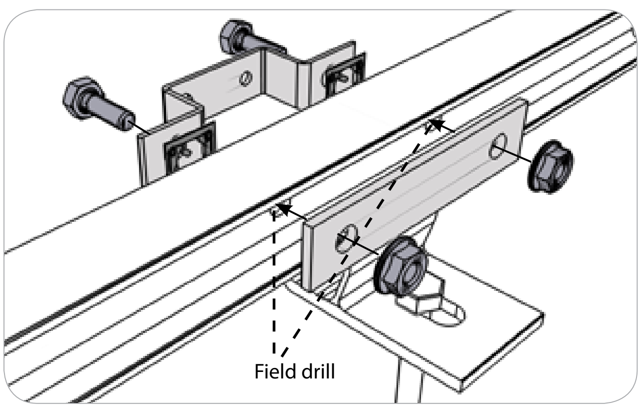




Step 4B: Install Retaining Clip

Option 2 - Use as a retaining clip on single beam applications

NOTE: Tighten nut to 75 inch pounds without anti-seize.
NOTE: Sliders cannot be moved along beam once retaining clip is installed.

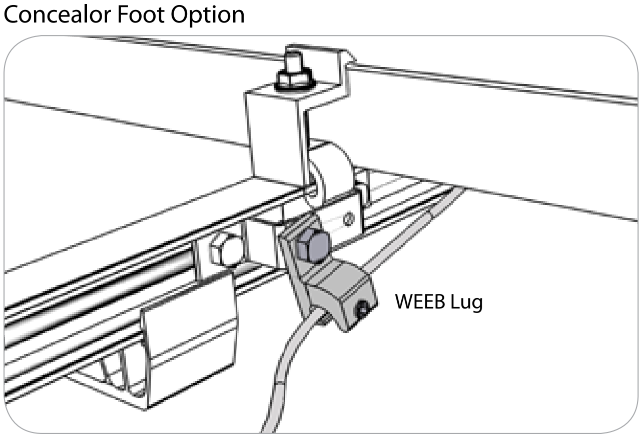


NOTES ON THERMAL EXPANSION:

CLICKSYS is designed to minimize the effects of thermal expansion by allowing the beams to expand and contract independently between connections and attachments. To minimize the effect of thermal expansion, restrict continuous beam lengths to 36 feet or three standard beam lengths.

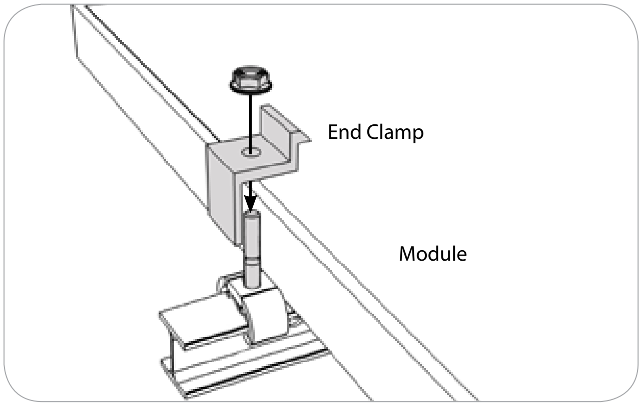
Step 5: Install Grounding Lugs

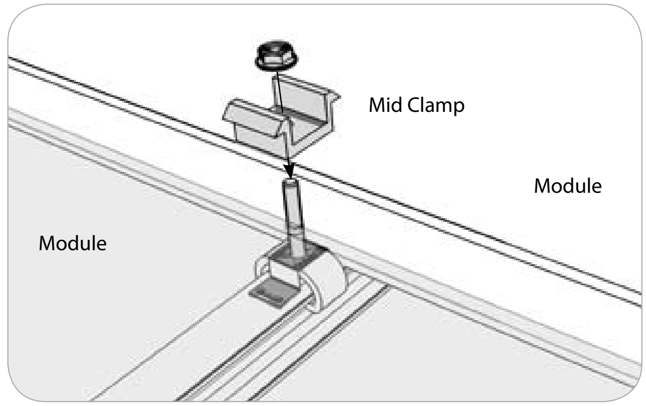
Concealor Foot Option



Step 6: Install modules using top mounting hardware

NOTE: Tighten nut to 75 inch pounds without anti-seize.





Part II. Procedure to Determine the Design Wind Load

[1.1.] Using the Simplified Method - ASCE 7-05

The procedure to determine Design Wind Load is specified by the American Society of Civil Engineers and referenced in the International Building Code 2006. The values, equations and procedures used in this document reference ASCE 7-05, Minimum Design Loads for Buildings and Other Structures. Please refer to ASCE 7-05 if you have any questions about the definitions or procedures presented in this manual. Unirac uses Method 1, the Simplified Method, for calculating the Design Wind Load for pressures on components and cladding in this document.

The method described in this document is valid for flush CLICKSYS™ applications on either roofs or walls. Flush is defined as panels parallel to the surface (or with no more than 3" difference between ends of assembly) with no more than 10" space between the roof surface, and the bottom of the PV modules. This method is not approved for open structure calculations. Applications of these procedures is subject to the following ASCE 7-05 limitations:

1. The building height must be less than 60 feet, h < 60'. See note for determining h in the next section. For installations on structures greater than 60 feet, contact your local Unirac distributor.

2. The building must be enclosed, not an open or partially enclosed structure, for example a carport.

3. The building is regular shaped with no unusual geometrical irregularity in spatial form, for example a geodesic dome.

4. The building is not in an extreme geographic location such as a narrow canyon or steep cliff.

5. The building has a flat or gable roof with a pitch less than 45 degrees or a hip roof with a pitch less than 27 degrees.

6. If your installation does not conform to these requirements please contact your local Unirac distributor, a local professional engineer or Unirac

If your installation is outside the United States or does not meet all of these limitations, consult a local professional engineer or your local building authority. Consult ASCE 7-05 for more clarification on the use of Method 1. Lower design wind loads may be obtained by applying Method 2 from ASCE 7-05. Consult with a licensed engineer if you want to use Method 2 procedures.

The equation for determining the Design Wind Load for components and cladding is:

(equation 1) $p_{net}\ (psf) = \lambda K_{zt} I\, p_{net30}$

p_{net} (psf) = Design Wind Load

λ = Adjustment factor for height and exposure category

K_{zt} = Topographic Factor at mean roof height, h (ft)

I = Importance Factor

p_{net30} (psf) = net design wind pressure for Exposure B, at height = 30, I = 1

You will also need to know the following information:

Basic Wind Speed = V (mph), the largest 3 second gust of wind in the last 50 years.

h (ft) = total roof height for flat roof buildings or mean roof height for pitched roof buildings

Effective Wind Area (sf) = minimum total continuous area of modules being installed

Roof Zone = the area of the roof in which you are installing the pv system according to Figure 2, page 5.

Roof Zone Setback Length = a (ft)

Roof Pitch (degrees)

Exposure Category (B, C, or D per ASCE 7-05)

[1.2.] Procedure to Calculate Total Design Wind

The procedure for determining the Design Wind Load can be broken into steps that include looking up several values in different tables.

Step 1: Determine Basic Wind Speed, V (mph)

Determine the Basic Wind Speed, V (mph) by consulting your local building department or locating your installation on the map in Figure 1, page 4.

Step 2: Determining Effective Wind Area

Determine the smallest area of continuous modules you will be installing. This is the smallest area tributary (contributing load) to a support or to a simple-span of beam. That area is the Effective Wind Area.

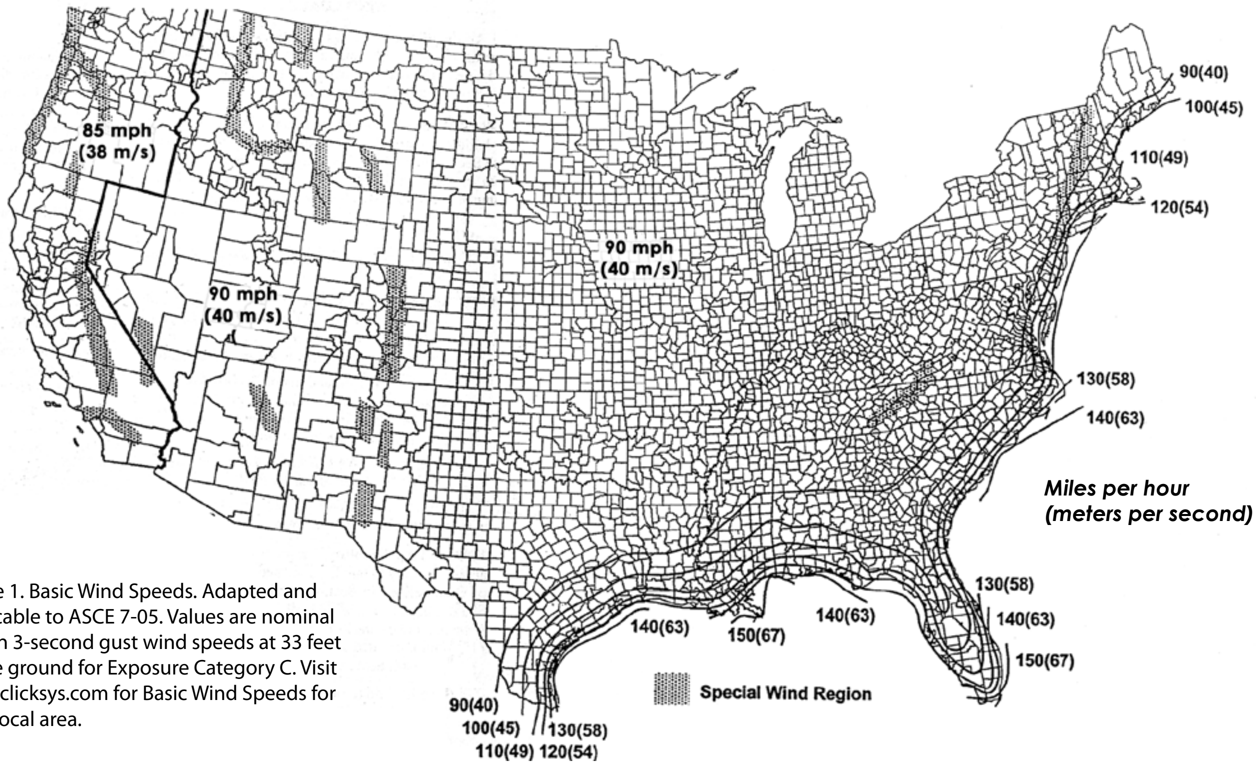


Figure 1. Basic Wind Speeds. Adapted and applicable to ASCE 7-05. Values are nominal design 3-second gust wind speeds at 33 feet above ground for Exposure Category C. Visit www.clicksys.com for Basic Wind Speeds for your local area.

Step 3: Determine Roof/Wall Zone

The Design Wind Load will vary based on where the installation is located on a roof. Arrays may be located in more than one roof zone.

Using Table 1, determine the Roof Zone Setback Length, a (ft), according to the width and height of the building on which you are installing the pv system.

Table 1. Determine Roof/Wall Zone, length (**a**) according to building width and height

a = 10 percent of the least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of the least horizontal dimension or 3 ft of the building.

Roof Height (ft)	*Least Horizontal Dimension (ft)*																		
	10	***15***	***20***	***25***	***30***	***40***	***50***	***60***	***70***	***80***	***90***	***100***	***125***	***150***	***175***	***200***	***300***	***400***	***500***
10	3	3	3	3	3	4	4	4	4	4	4	4	5	6	7	8	12	16	20
15	3	3	3	3	3	4	5	6	6	6	6	6	6	6	7	8	12	16	20
20	3	3	3	3	3	4	5	6	7	8	8	8	8	8	8	8	12	16	20
25	3	3	3	3	3	4	5	6	7	8	9	10	10	10	10	10	12	16	20
30	3	3	3	3	3	4	5	6	7	8	9	10	12	12	12	12	12	16	20
35	3	3	3	3	3	4	5	6	7	8	9	10	12.5	14	14	14	14	16	20
40	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	16	16	16	16	20
45	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	18	18	18	20
50	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	20	20	20
60	3	3	3	3	3	4	5	6	7	8	9	10	12.5	15	17.5	20	24	24	24

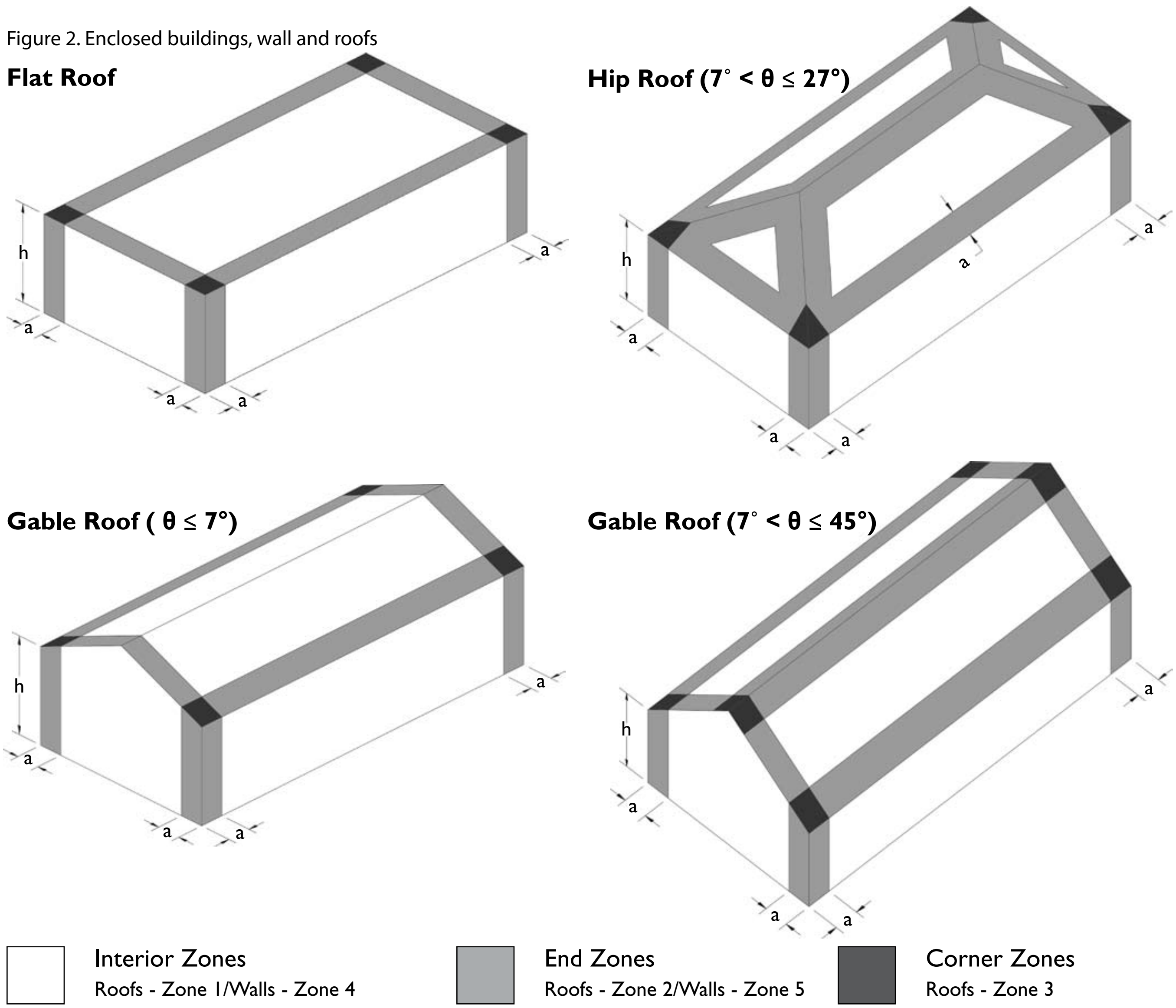
Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 41.

NOTE: Method 1 is not valid for buildings over 60' in height. Consult a licensed engineer to use Method 2.

Step 3: Determine Roof Zone (continued)

Using Roof Zone Setback Length, a, determine the roof zone locations according to your roof type, gable, hip or monoslope. Determine in which roof zone your pv system is located, Zone 1, 2, or 3 according to Figure 2.

Figure 2. Enclosed buildings, wall and roofs



Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, p. 41.

Step 4: Determine Net Design Wind Pressure, p_{net30} (psf)

Using the Basic Wind Speed (Step 1), Effective Wind Area (Step 2) and Roof Zone Location (Step 3), look up the appropriate Net Design Wind Pressure in Table 2, page 6. Use the Effective Wind Area value in the table which is smaller than the value calculated in Step 2. If the installation is located on a roof overhang, also use Table 3, page 7.

Both downforce and uplift pressures must be considered in overall design. Refer to Part II, Step 1 for applying downforce and uplift pressures. You will have two values for the Net Design Wind Pressure, one positive and one negative. Positive values are acting toward the surface (downforce), negative values are acting away from the surface (uplift).

Table 2. p_{net30} (psf) Roof and Wall

Basic Wind Speed, V (mph)

		Effective Wind Area	90		100		110		120		130		140		150		170	
	Zone	*(sf)*	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift	Downforce	Uplift
Roof 0 to 7 degrees	1	10	5.9	-14.6	7.3	-18.0	8.9	-21.8	10.5	-25.9	12.4	-30.4	14.3	-35.3	16.5	-40.5	21.1	-52.0
	1	20	5.6	-14.2	6.9	-17.5	8.3	-21.2	9.9	-25.2	11.6	-29.6	13.4	-34.4	15.4	-39.4	19.8	-50.7
	1	50	5.1	-13.7	6.3	-16.9	7.6	-20.5	9.0	-24.4	10.6	-28.6	12.3	-33.2	14.1	-38.1	18.1	-48.9
	1	100	4.7	-13.3	5.8	-16.5	7.0	-19.9	8.3	-23.7	9.8	-27.8	11.4	-32.3	13.0	-37.0	16.7	-47.6
	2	10	5.9	-24.4	7.3	-30.2	8.9	-36.5	10.5	-43.5	12.4	-51.0	14.3	-59.2	16.5	-67.9	21.1	-87.2
	2	20	5.6	-21.8	6.9	-27.0	8.3	-32.6	9.9	-38.8	11.6	-45.6	13.4	-52.9	15.4	-60.7	19.8	-78.0
	2	50	5.1	-18.4	6.3	-22.7	7.6	-27.5	9.0	-32.7	10.6	-38.4	12.3	-44.5	14.1	-51.1	18.1	-65.7
	2	100	4.7	-15.8	5.8	-19.5	7.0	-23.6	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	16.7	-56.4
	3	10	5.9	-36.8	7.3	-45.4	8.9	-55.0	10.5	-65.4	12.4	-76.8	14.3	-89.0	16.5	-102.2	21.1	-131.3
	3	20	5.6	-30.5	6.9	-37.6	8.3	-45.5	9.9	-54.2	11.6	-63.6	13.4	-73.8	15.4	-84.7	19.8	-108.7
	3	50	5.1	-22.1	6.3	-27.3	7.6	-33.1	9.0	-39.3	10.6	-46.2	12.3	-53.5	14.1	-61.5	18.1	-78.9
	3	100	4.7	-15.8	5.8	-19.5	7.0	-23.6	8.3	-28.1	9.8	-33.0	11.4	-38.2	13.0	-43.9	16.7	-56.4
Roof 7 to 27degrees	1	10	8.4	-13.3	10.4	-16.5	12.5	-19.9	14.9	-23.7	17.5	-27.8	20.3	-32.3	23.3	-37.0	30.0	-47.6
	1	20	7.7	-13.0	9.4	-16.0	11.4	-19.4	13.6	-23.0	16.0	-27.0	18.5	-31.4	21.3	-36.0	27.3	-46.3
	1	50	6.7	-12.5	8.2	-15.4	10.0	-18.6	11.9	-22.2	13.9	-26.0	16.1	-30.2	18.5	-34.6	23.8	-44.5
	1	100	5.9	-12.1	7.3	-14.9	8.9	-18.1	10.5	-21.5	12.4	-25.2	14.3	-29.3	16.5	-33.6	21.1	-43.2
	2	10	8.4	-23.2	10.4	-28.7	12.5	-34.7	14.9	-41.3	17.5	-48.4	20.3	-56.2	23.3	-64.5	30.0	-82.8
	2	20	7.7	-21.4	9.4	-26.4	11.4	-31.9	13.6	-38.0	16.0	-44.6	18.5	-51.7	21.3	-59.3	27.3	-76.2
	2	50	6.7	-18.9	8.2	-23.3	10.0	-28.2	11.9	-33.6	13.9	-39.4	16.1	-45.7	18.5	-52.5	23.8	-67.4
	2	100	5.9	-17.0	7.3	-21.0	8.9	-25.5	10.5	-30.3	12.4	-35.6	14.3	-41.2	16.5	-47.3	21.1	-60.8
	3	10	8.4	-34.3	10.4	-42.4	12.5	-51.3	14.9	-61.0	17.5	-71.6	20.3	-83.1	23.3	-95.4	30.0	-122.5
	3	20	7.7	-32.1	9.4	-39.6	11.4	-47.9	13.6	-57.1	16.0	-67.0	18.5	-77.7	21.3	-89.2	27.3	-114.5
	3	50	6.7	-29.1	8.2	-36.0	10.0	-43.5	11.9	-51.8	13.9	-60.8	16.1	-70.5	18.5	-81.0	23.8	-104.0
	3	100	5.9	-26.9	7.3	-33.2	8.9	-40.2	10.5	-47.9	12.4	-56.2	14.3	-65.1	16.5	-74.8	21.1	-96.0
Roof 27 to 45 degrees	1	10	13.3	-14.6	16.5	-18.0	19.9	-21.8	23.7	-25.9	27.8	-30.4	32.3	-35.3	37.0	-40.5	47.6	-52.0
	1	20	13.0	-13.8	16.0	-17.1	19.4	-20.7	23.0	-24.6	27.0	-28.9	31.4	-33.5	36.0	-38.4	46.3	-49.3
	1	50	12.5	-12.8	15.4	-15.9	18.6	-19.2	22.2	-22.8	26.0	-26.8	30.2	-31.1	34.6	-35.7	44.5	-45.8
	1	100	12.1	-12.1	14.9	-14.9	18.1	-18.1	21.5	-21.5	25.2	-25.2	29.3	-29.3	33.6	-33.6	43.2	-43.2
	2	10	13.3	-17.0	16.5	-21.0	19.9	-25.5	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	47.6	-60.8
	2	20	13.0	-16.3	16.0	-20.1	19.4	-24.3	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	46.3	-58.1
	2	50	12.5	-15.3	15.4	-18.9	18.6	-22.9	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	44.5	-54.6
	2	100	12.1	-14.6	14.9	-18.0	18.1	-21.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	40.5	43.2	-52.0
	3	10	13.3	-17.0	16.5	-21.0	19.9	-25.5	23.7	-30.3	27.8	-35.6	32.3	-41.2	37.0	-47.3	47.6	-60.8
	3	20	13.0	-16.3	16.0	-20.1	19.4	-24.3	23.0	-29.0	27.0	-34.0	31.4	-39.4	36.0	-45.3	46.3	-58.1
	3	50	12.5	-15.3	15.4	-18.9	18.6	-22.9	22.2	-27.2	26.0	-32.0	30.2	-37.1	34.6	-42.5	44.5	-54.6
	3	100	12.1	-14.6	14.9	-18.0	18.1	-21.8	21.5	-25.9	25.2	-30.4	29.3	-35.3	33.6	-40.5	43.2	-52.0
Wall	4	10	14.6	-15.8	18.0	-19.5	21.8	-23.6	25.9	-28.1	30.4	-33.0	35.3	-38.2	40.5	-43.9	52.0	-56.4
	4	20	13.9	-15.1	17.2	-18.7	20.8	-22.6	24.7	-26.9	29.0	-31.6	33.7	-36.7	38.7	-42.1	49.6	-54.1
	4	50	13.0	-14.3	16.1	-17.6	19.5	-21.3	23.2	-25.4	27.2	-29.8	31.6	-34.6	36.2	-39.7	46.6	-51.0
	4	100	12.4	-13.6	15.3	-16.8	18.5	-20.4	22.0	-24.2	25.9	-28.4	30.0	-33.0	34.4	-37.8	44.2	-48.6
	4	500	10.9	-12.1	13.4	-14.9	16.2	-18.1	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	38.8	-43.2
	5	10	14.6	-19.5	18.0	-24.1	21.8	-29.1	25.9	-34.7	30.4	-40.7	35.3	-47.2	40.5	-54.2	52.0	-69.6
	5	20	13.9	-18.2	17.2	-22.5	20.8	-27.2	24.7	-32.4	29.0	-38.0	33.7	-44.0	38.7	-50.5	49.6	-64.9
	5	50	13.0	-16.5	16.1	-20.3	19.5	-24.6	23.2	-29.3	27.2	-34.3	31.6	-39.8	36.2	-45.7	46.6	-58.7
	5	100	12.4	-15.1	15.3	-18.7	18.5	-22.6	22.0	-26.9	25.9	-31.6	30.0	-36.7	34.4	-42.1	44.2	-54.1
	5	500	10.9	-12.1	13.4	-14.9	16.2	-18.1	19.3	-21.5	22.7	-25.2	26.3	-29.3	30.2	-33.6	38.8	-43.2

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 42-43.

Table 3. p_{net30} (psf) Roof Overhang

	Zone	Effective Wind Area (sf)	Basic Wind Speed, V (mph) 90	100	110	120	130	140	150	170
Roof 0 to 7 degrees	2	10	-21.0	-25.9	-31.4	-37.3	-43.8	-50.8	-58.3	-74.9
	2	20	-20.6	-25.5	-30.8	-36.7	-43.0	-49.9	-57.3	-73.6
	2	50	-20.1	-24.9	-30.1	-35.8	-42.0	-48.7	-55.9	-71.8
	2	100	-19.8	-24.4	-29.5	-35.1	-41.2	-47.8	-54.9	-70.5
	3	10	-34.6	-42.7	-51.6	-61.5	-72.1	-83.7	-96.0	-123.4
	3	20	-27.1	-33.5	-40.5	-48.3	-56.6	-65.7	-75.4	-96.8
	3	50	-17.3	-21.4	-25.9	-30.8	-36.1	-41.9	-48.1	-61.8
	3	100	-10.0	-12.2	-14.8	-17.6	-20.6	-23.9	-27.4	-35.2
Roof 7 to 27degrees	2	10	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	20	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	50	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	2	100	-27.2	-33.5	-40.6	-48.3	-56.7	-65.7	-75.5	-96.9
	3	10	-45.7	-56.4	-68.3	-81.2	-95.3	-110.6	-126.9	-163.0
	3	20	-41.2	-50.9	-61.6	-73.3	-86.0	-99.8	-114.5	-147.1
	3	50	-35.3	-43.6	-52.8	-62.8	-73.7	-85.5	-98.1	-126.1
	3	100	-30.9	-38.1	-46.1	-54.9	-64.4	-74.7	-85.8	-110.1
Roof 27 to 45 degrees	2	10	-24.7	-30.5	-36.9	-43.9	-51.5	-59.8	-68.6	-88.1
	2	20	-24.0	-29.6	-35.8	-42.6	-50.0	-58.0	-66.5	-85.5
	2	50	-23.0	-28.4	-34.3	-40.8	-47.9	-55.6	-63.8	-82.0
	2	100	-22.2	-27.4	-33.2	-39.5	-46.4	-53.8	-61.7	-79.3
	3	10	-24.7	-30.5	-36.9	-43.9	-51.5	-59.8	-68.6	-88.1
	3	20	-24.0	-29.6	-35.8	-42.6	-50.0	-58.0	-66.5	-85.5
	3	50	-23.0	-28.4	-34.3	-40.8	-47.9	-55.6	-63.8	-82.0
	3	100	-22.2	-27.4	-33.2	-39.5	-46.4	-53.8	-61.7	-79.3

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, p. 44.

Step 5: Determine the Topographic Factor, K_{zt}

For the purposes of this code compliance document, the Topographic Factor, K_{zt}, is taken as equal to one (1), meaning, the installation is on level ground (less than 10% slope). If the installation is not on level ground, please consult ASCE 7-05, Section 6.5.7 and the local building authority to determine the Topographic Factor.

Step 6: Determine Exposure Category (B, C, D)

Determine the Exposure Category by using the following definitions for Exposure Categories.

The ASCE/SEI 7-05 defines wind exposure categories* as follows:

EXPOSURE B is urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single family dwellings.

EXPOSURE C has open terrain with scattered obstructions having heights generally less than 30 feet. This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions.

EXPOSURE D has flat, unobstructed areas and water surfaces outside hurricane prone regions. This category includes smooth mud flats, salt flats, and unbroken ice.

*See ASCE 7-05 pages 287-291 for further explanation and explanatory photographs, and confirm your selection with the local building authority.

Step 7: Determine adjustment factor for height and exposure category, **λ**

Using the Exposure Category (Step 6) and the roof height, h (ft), look up the adjustment factor for height and exposure in Table 4.

Step 8: Determine the Importance Factor, I

Determine if the installation is in a hurricane prone region. Look up the Importance Factor, I, Table 6, page 9, using the occupancy category description and the hurricane prone region status.

Step 9: Calculate the Design Wind Load, p_{net} (psf)

Multiply the Net Design Wind Pressure, p_{net30} (psf)(Step 4) by the adjustment factor for height and exposure, λ (Step 7), the Topographic Factor, K_{zt} (Step 5), and the Importance Factor, I (Step 8) using the following equation:

(equation 1) p_{net} (psf) = $\lambda K_{zt} I \, p_{net30}$

p_{net} (psf) = Design Wind Load (10 psf minimum)

λ = Adjustment factor for height and exposure category (Step 7)

K_{zt} = Topographic Factor at mean roof height, h (ft) (Step 5)

I = Importance Factor (Step 8)

p_{net30} (psf) = net design wind pressure for Exposure B, at height = 30, I = 1 (Step 4)

Use Table 5 below to calculate Design Wind Load.

The Design Wind Load will be used in Part II to select the appropriate beam span and foot spacing. ASCE 7-05 requires the minimum wind load to be 10psf. If a lower value is calculated, 10psf must be used.

Table 4. Adjustment Factor for Roof Height & Exposure Category

Mean roof height (ft)	*Exposure*		
	B	**C**	**D**
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

Source: ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 6, Figure 6-3, p. 44.

Table 5. Worksheet for Components and Cladding Wind Load Calculation: IBC 2006, ASCE 7-05

Variable Description	*Symbol*	*Value*	*Unit*	*Step*	*Reference*
Building Height	h		ft		
Building, Least Horizontal Dimension			ft		
Roof Pitch			degrees		
Exposure Category				6	
Basic Wind Speed	V		mph	1	Figure 1
Effective Wind Area			sf	2	
Roof Zone Setback Length	a		ft	3	Table 1
Roof Zone Location				3	Figure 2
Net Design Wind Pressure	p_{net30}		psf	4	Table 2, 3
Topographic Factor	K_{zt}	x		5	
Adjustment factor for height and exposure category	λ	x		7	Table 4
Importance Factor	I	x		8	Table 6
Total Design Wind Load	p_{net}		psf	9	

Table 6. Occupancy Category Importance Factor

Category	*Category Description*	*Building Type Examples*	*Non-Hurricane Prone Regions and Hurricane Prone Regions with Basic Wind Speed, V = 85-100 mph, and Alaska*	*Hurricane Prone Regions with Basic Wind Speed, V > 100mph*
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including, but limited to:	Agricultural facilities Certain Temporary facilities Minor Storage facilities	0.87	0.77
II	All buildings and other structures except those listed in Occupancy Categories I, III, and IV.		1	1
III	Buildings and other structures that represent a substantial hazard to human life in the event of a failure, including, but not limited to:	Buildings where more than 300 people congregate in one area Schools with a capacity more than 250 Day Cares with a capacity more than 150 Buildings for colleges with a capacity more than 500 Health Care facilities with a capacity of 50 or more resident patients Jails and Detention Facilities Power Generating Stations Water and Sewage Treatment Facilities Telecommunication Centers Buildings that manufacture or house hazardous materials	1.15	1.15
IV	Buildings and other structures designated as essential facilities, including, but not limited to:	Hospitals and other health care facilities having surgery or emergency treatment Fire, rescue, ambulance and police stations Designated earthquake, hurricane, or other emergency shelters Designated emergency preparedness communication, and operation centers Power generating stations and other public utility facilities required in an emergency Ancillary structures required for operation of Occupancy Category IV structures Aviation control towers, air traffic control centers, and emergency aircraft hangars Water storage facilities and pump structures required to maintain water pressure for fire suppression Buildings and other structures having critical national defense functions	1.15	1.15

Source: IBC 2006, Table 1604.5, Occupancy Category of Buildings and other structures, p. 281; ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, Table 6-1, p. 3 and p. 77

Part III. Procedure to Select Beam Span

[2.1.] Using Standard Beam Calculations, Structural Engineering Methodology

The procedure to determine CLICKSYS™ beam span uses standard beam calculations and structural engineering methodology. The beam calculations are based on a simply supported beam, conservatively ignoring the reductions allowed for supports of continuous beams over multiple supports. Please refer to Part I for more information on wind load calculations, equations and assumptions.

Using this document, obtaining correct results is dependent upon the following:

1. Obtain the Snow Load for your area from your local building official.

2. Obtain the Design Wind Load, p_{net}. See Part I (Procedure to Determine the Design Wind Load) for more information on calculating the Design Wind Load.

3. Please Note: The terms beam span and foot spacing are interchangeable in this document. See Figure 3 for illustrations.

4. To use Table 8 and Table 9 the Dead Load for your specific installation must be less than 5 psf, including modules and Unirac racking systems. If the Dead Load is greater than 3.1 psf, see your Unirac distributor, a local structural engineer or contact Unirac.

The following procedure will guide you in selecting a Unirac beam for a flush mount installation. It will also help determine the design loading imposed by the Unirac PV Mounting Assembly that the building structure must be capable of supporting.

Step 1: Determine the Total Design Load

The Total Design Load, P (psf) is determined using ASCE 7-05 2.4.1 (ASD Method equations 3,5,6 and 7) by adding the Snow Load[1], S (psf), Design Wind Load, p_{net} (psf) from Part I, Step 9 and the Dead Load, D (psf). Both Uplift and Downforce Wind Loads calculated in Step 9 of Part 2 must be investigated. Use Table 7 to calculate the Total Design Load for load cases. Use the maximum absolute value of the three downforce cases and the uplift case for sizing the beam. Use the uplift case only for sizing lag bolts pull out capacities (Part II, Step 6).

P (psf) = $1.0D + 1.0S^1$ (downforce case 1, equation 2)

P (psf) = $1.0D + 1.0p_{net}$ (downforce case 2, equation 3)

P (psf) = $1.0D + 0.75S^1 + 0.75p_{net}$ (downforce case 3, equation 4)

P (psf) = $0.6D + 1.0p_{net}$ (uplift, equation 5)

D = Dead Load (psf)

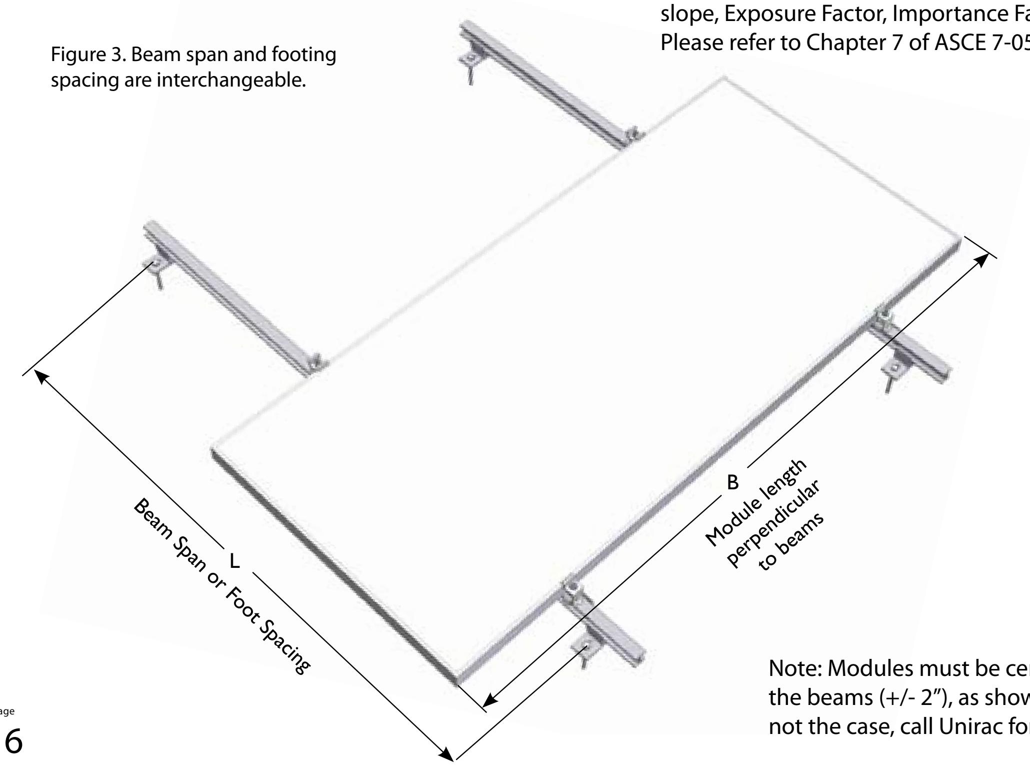
S = Snow Load (psf)

p_{net} = Design Wind Load (psf) (Positive for downforce, negative for uplift)

The maximum Dead Load, D (psf), is 5 psf based on market research and internal data.

[1] Snow Load Reduction - The snow load can be reduced according to Chapter 7 of ASCE 7-05. The reduction is a function of the roof slope, Exposure Factor, Importance Factor and Thermal Factor. Please refer to Chapter 7 of ASCE 7-05 for more information.

Figure 3. Beam span and footing spacing are interchangeable.



Note: Modules must be centered symmetrically on the beams (+/- 2"), as shown in Figure 3. If this is not the case, call Unirac for assistance.

Table 7. ASCE 7-05 ASD Load Combinations

Description	Variable	Downforce Case 1	Downforce Case 2	Downforce Case 3	Uplift	units
Dead Load	D	1.0 x	1.0 x	1.0 x	0.6 x	psf
Snow Load	S	1.0 x + _______		0.75 x + _______		psf
Design Wind Load	Pnet		1.0 x + _______	0.75 x + _______	1.0 x - _______	psf
Total Design Load	P					psf

Note: Table to be filled out or attached for evaluation.

Step 2: Determine the Distributed Load on the beam, w (plf)

Determine the Distributed Load, w (plf), by multiplying the module length, B (ft), by the Total Design Load, P (psf) and dividing by two. Use the maximum absolute value of the three downforce cases and the Uplift Case. We assume each module is supported by two beams.

(equation 6) $w = PB/2$

w = Distributed Load (pounds per linear foot, plf)

B = Module Length Perpendicular to Beams (ft)

P = Total Design Pressure (pounds per square foot, psf)

Step 3: Determine Beam Span/1 Flange/2 Flange Connection Spacing

The1 Flange/2 Flange Beam Span Table uses a single 1 Flange/2 Flange connection to the roof, wall or stand-off. Please refer to Part III for more installation information.

Table 8. 1 Flange and 2 Flange Beam Span

Span (ft)	w = Distributed Load (plf)													
	20	25	30	40	50	60	80	100	120	140	160	180	200	220
2	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100
2.5	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100		
3	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100				
3.5	CS100	CS100	CS100	CS100	CS100	CS100	CS100	CS100						
4	CS100	CS100	CS100	CS100	CS100	CS100								
4.5	CS100	CS100	CS100	CS100	CS100									

Step 4: Determine the Downforce Point Load, R_d (lbs), at each connection based on beam span

When designing the Unirac Flush Mount Installation, you must consider the downforce Point Load, R (lbs) on the roof structure.

The Downforce, Point Load, R (lbs), is determined by multiplying the Total Design Load, P (psf) (Step 1) by the Beam Span, L (ft) (Step 3) and the Module Length Perpendicular to the Beams, B (ft) divided by two.

(equation 7) R (lbs) = PLB/2

OR

(equation 8) R =wL

R = Point Load (lbs)

w = Distributed Load (plf)

P = Total Design Load (psf)

L = Beam Span (ft)

B = Module Length Perpendicular to Beams (ft)

It is the installer's responsibility to verify that the building structure is strong enough to support the maximum point loads calculated according to this step and Step 5.

See Table 9

Table 9. Downforce Point Load Calculation

Total Design Load (downforce) (max of case 1, 2 or 3)	P		psf	Step 1
Module length perpendicular to beams	B	x	ft	
Beam Span	L	x	ft	Step 4
		/2		
Downforce Point Load	R		lbs	

Step 5: Determine the Uplift Point Load, R (lbs), at each connection based on beam span

You must also consider the Uplift Point Load, R (lbs), to determine the required lag bolt or concealor screw attachment to the roof (building) structure.

(equation 7) R (lbs) = PL B/2

OR

(equation 8) R (lbs) = wL

w = Distributed Load

Table 10. Uplift Point Load Calculation

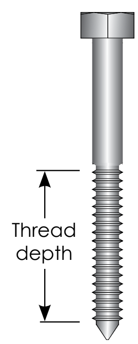
Total Design Load (uplift)	P		psf	Step 1
Module length perpendicular to beams	B	x	ft	
Beam Span	L	x	ft	Step 4
		/2		
Uplift Point Load	R		lbs	

Use Table 11 and 12 to select a lag bolt or concealor screw size and embedment depth to satisfy your Uplift Point Load Force, R_u (lbs), requirements.

It is the installer's responsibility to verify that the substructure and attachment method is strong enough to support the maximum point loads calculated according to Step 4 and Step 5.

Table 11. Lag pull-out (withdrawal) capacities (lbs) in typical roof lumber (ASD)

	Specific gravity	*Lag screw specifications* 5/16" shaft,* per inch thread depth
Douglas Fir, Larch	**0.50**	**266**
Douglas Fir, South	**0.46**	**235**
Engelmann Spruce, Lodgepole Pine (MSR 1650 f & higher)	**0.46**	**235**
Hem, Fir, Redwood (close grain)	**0.43**	**212**
Hem, Fir (North)	**0.46**	**235**
Southern Pine	**0.55**	**307**
Spruce, Pine, Fir	**0.42**	**205**
Spruce, Pine, Fir (E of 2 million psi and higher grades of MSR and MEL)	**0.50**	**266**



Sources: American Wood Council, NDS 2005, Table 11.2A, 11.3.2A.

Notes: (1) Thread must be embedded in the side grain of a rafter or other structural member integral with the building structure.
(2) Lag bolts must be located in the middle third of the structural member.
(3) These values are not valid for wet service.
(4) This table does not include shear capacities. If necessary, contact a local engineer to specifiy lag bolt size with regard to shear forces.
(5) Install lag bolts with head and washer flush to surface (no gap). Do not over-torque.
(6) Withdrawal design values for lag screw connections shall be multiplied by applicable adjustment factors if necessary. See Table 10.3.1 in the American Wood Council NDS for Wood Construction.

**Use flat washers with lag screws. Flat washers are not necessary with concealor screws.*

Table 12. Concealor Screw pull-out (withdrawal) ultimate capacities (lbs)

	Wood Type						
Fastener Dia. & Point	**1/2" Plywood**	**5/8" Plywood**	**3/4" Plywood**	**7/16" OSB**	**13/32" OSB**	**21/32" OSB**	**2x4 SYP**
#10-12 GP	**350**	**390**	**550**	**234**	**326**	**352**	**800**
#10-9 GP	**362**	**396**	**558**	**235**	**331**	**358**	**810**
#12-14 DP1/Lap	**376**	**415**	**598**	**251**	**351**	**378**	**860**
#12-14 GP	**377**	**418**	**600**	**255**	**356**	**382**	**865**

Sources: Triangle Fasteners Form #JS091805 REV4

Notes: (1) A minimum safety factor of 3 should be used.
(2) Concealor screws must be located in the middle third of the structural member.
(3) This table does not include shear capacities. Contact Triangle Fasteners for more information.
(4) Install screws with head flush with mount surface (no gap). Do not over-torque.

10 year limited Product Warranty

Unirac, Inc., warrants to the original purchaser ("Purchaser") of product(s) that it manufactures ("Product") at the original installation site that the Product shall be free from defects in material and workmanship for a period of ten (10) years, from the earlier of 1) the date the installation of the Product is completed, or 2) 30 days after the purchase of the Product by the original Purchaser.

The Warranty does not apply to any foreign residue deposited on the finish. All installations in corrosive atmospheric conditions are excluded. This Warranty does not cover damage to the Product that occurs during its shipment, storage, or installation.

This Warranty shall be VOID if installation of the Product is not performed in accordance with Unirac's written installation instructions and design specifications therein, or if the Product has been modified, repaired, or reworked in a manner not previously authorized by Unirac IN WRITING, or if the Product is installed in an environment for which it was not designed. Unirac shall not be liable for consequential, contingent or incidental damages arising out of the use of the Product by Purchaser under any circumstances.

If within the specified Warranty period the Product shall be reasonably proven to be defective, then Unirac shall repair or replace the defective Product, or any part thereof, in Unirac's sole discretion. Such repair or replacement shall completely satisfy and discharge all of Unirac's liability with respect to this limited Warranty. Under no circumstances shall Unirac be liable for special, indirect or consequential damages arising out of or related to use by Purchaser of the Product.

Manufacturers of related items, such as PV modules and flashings, may provide written warranties of their own. Unirac's limited Warranty covers only its Product, and not any related items.

Glossary

- ASCE 7-05 = The most current standard referenced in the International Building Code 2006 used to calculate minimum design loads for buildings and other structures.
- p_{net}, Design Wind Load (psf) = the calculated load due to wind using ASCE 7-05 Standard
- λ, adjustment factor for height and exposure category = a weighted factor to increase or decrease the wind load based on local geography and building height
- K_{zt}, Topographic Factor at mean roof height, h (ft) = a weighted factor to increase or decrease the wind load based on local topography
- I, Importance Factor = a weighted factor to increase or decrease the load based on occupancy usage.
- p_{net30} (psf), net design wind pressure for Exposure B, at height, h = ft, Importance Factor, I = 1 = a value for wind load used in Method 1 for calculating wind load for components and cladding
- V (mph), Basic Wind Speed = the largest 3 second gust of wind recorded in the last 50 years in a local area
- h, roof height (ft) = total roof height for flat roof buildings or mean roof height for pitched roof buildings
- A, Effective Wind Area (sf) = minimum total continuous area of modules being installed
- Roof Zone = the relative location on the roof in which you are installing the pv system according to Figure 2, page ???
- a, Roof Zone setback length (ft) = the distance from the edge of a roof that determines the boundaries of the roof zones defined in ASCE 7-05
- Roof Pitch (degrees) = the slope of the roof of a building or structure measured at an acute angle to the horizon
- Exposure Category (B, C, D) = a classification of the surface roughness of the surrounding terrain
- Downforce = the positive value of wind load calculated perpendicular and toward the surface of a structure
- Uplift = the negative value of wind load calculated perpendicular and away from the surface of a structure
- D, Dead Load (psf) = the self weight on a structure or component of a structure over a given area
- S, Snow Load (psf) = the required design load due to snow
- P, Total Design Pressure (psf) = the resultant load calculated using Dead, Snow and Wind as factors
- w, distributed load (plf) = the average load per foot applied to a beam or other member
- B, module length perpendicular to rails (ft) = the length of a solar module measured perpendicular to the beams or rails of a racking system
- L, Beam Span or Foot Spacing (ft) = the unsupported distance between supports on a beam, the distance between connections on a beam or rail
- R, Point Load (lbs) = the amount of force applied at the point of contact of the racking system to the substructure

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