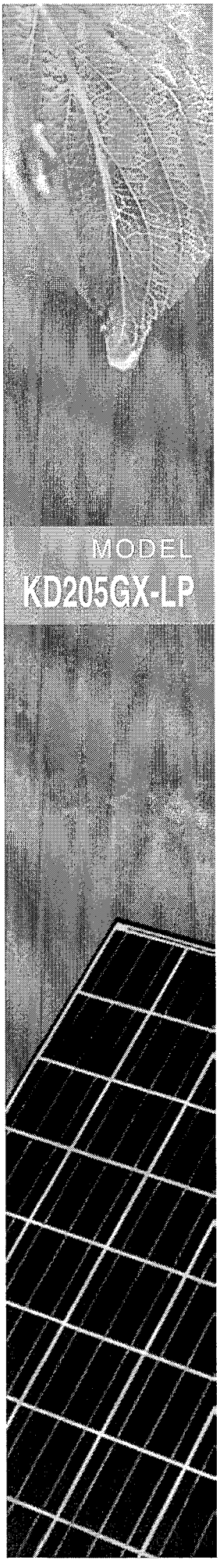
KYOCERA MODULE

KD205GX-LP
High Efficiency Multicrystal Photovoltaic Module

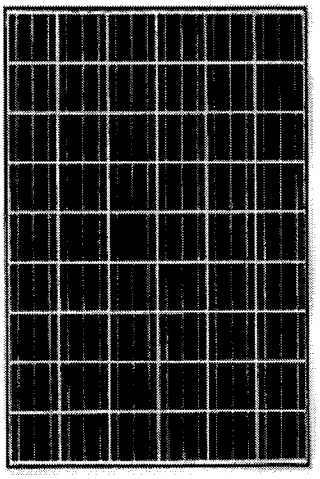


THE NEW VALUE FRONTIER

KYOCERA

KD205GX-LP

HIGH EFFICIENCY MULTICRYSTAL
PHOTOVOLTAIC MODULE



LISTED

HIGHLIGHTS OF KYOCERA PHOTOVOLTAIC MODULES

Kyocera's advanced cell processing technology and automated production facilities produce a highly efficient multicrystal photovoltaic module.
The conversion efficiency of the Kyocera solar cell is over 16%.
These cells are encapsulated between a tempered glass cover and a pottant with back sheet to provide efficient protection from the severest environmental conditions.
The entire laminate is installed in an anodized aluminum frame to provide structural strength and ease of installation.
Equipped with plug-in connectors.

APPLICATIONS

KD205GX-LP is ideal for grid tie system applications.

- Residential roof top systems
- Large commercial grid tie systems
- Water Pumping systems
- High Voltage stand alone systems
- etc.

QUALIFICATIONS

- **MODULE** : UL1703 listed
- **FACTORY** : ISO9001 and ISO 14001

QUALITY ASSURANCE

Kyocera multicrystal photovoltaic modules have passed the following tests.

- Thermal cycling test
- Thermal shock test
- Thermal / Freezing and high humidity cycling test
- Electrical isolation test
- Hail impact test
- Mechanical, wind and twist loading test
- Salt mist test
- Light and water-exposure test
- Field exposure test

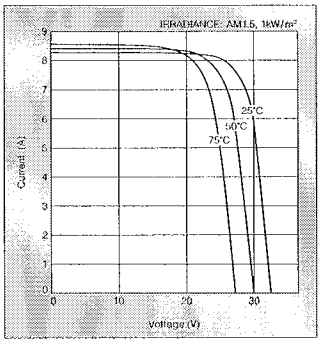
LIMITED WARRANTY

※1 year limited warranty on material and workmanship
※20 years limited warranty on power output: For detail, please refer to "category IV" in Warranty issued by Kyocera

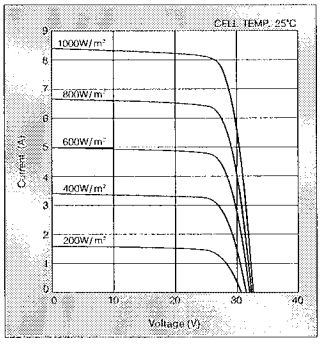
(Long term output warranty shall warrant if PV Module(s) exhibits power output of less than 90% of the original minimum rated power specified at the time of sale within 10 years and less than 80% within 20 years after the date of sale to the Customer. The power output values shall be those measured under Kyocera's standard measurement conditions. Regarding the warranty conditions in detail, please refer to Warranty issued by Kyocera)

ELECTRICAL CHARACTERISTICS

Current-Voltage characteristics of Photovoltaic Module KD205GX-LP at various cell temperatures

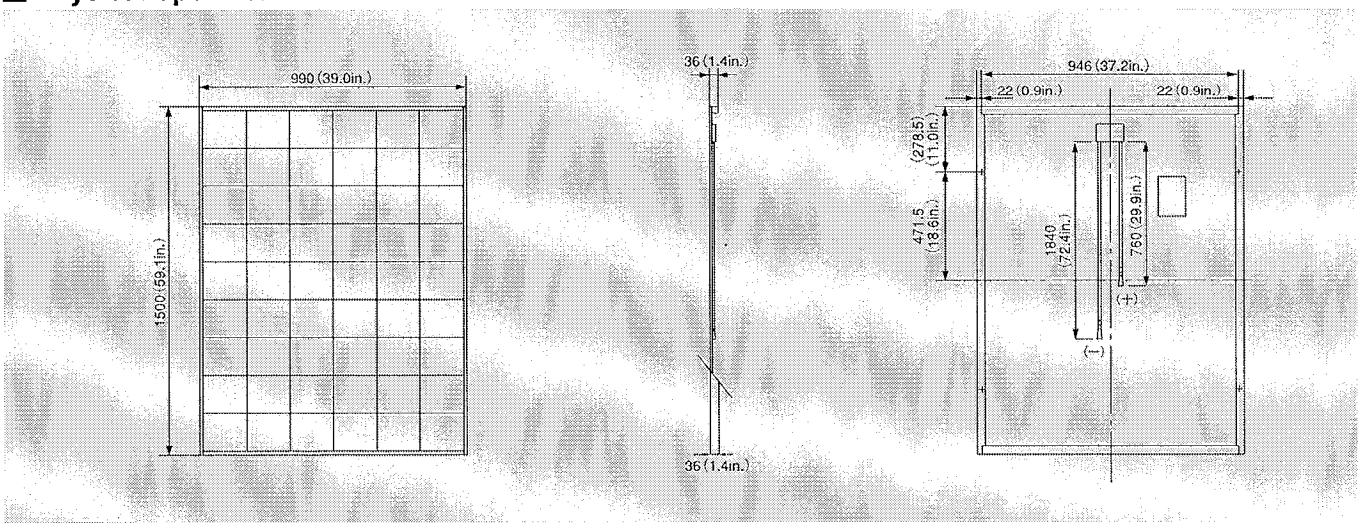


Current-Voltage characteristics of Photovoltaic Module KD205GX-LP at various irradiance levels



Physical Specifications

Unit : mm (in.)



Specifications

Electrical Performance under Standard Test Conditions (*STC)	
Maximum Power (Pmax)	205W (+5%/−5%)
Maximum Power Voltage (Vmpp)	26.6V
Maximum Power Current (Impp)	7.71A
Open Circuit Voltage (Voc)	33.2V
Short Circuit Current (Isc)	8.36A
Max System Voltage	600V
Temperature Coefficient of Voc	−0.120 V/℃
Temperature Coefficient of Isc	5.02×10^{-3} A/℃

*STC : Irradiance 1000W/m², AM1.5 spectrum, cell temperature 25℃

Electrical Performance at 800W/m², *NOCT, AM1.5	
Maximum Power (Pmax)	145W
Maximum Power Voltage (Vmpp)	23.5V
Maximum Power Current (Impp)	6.17A
Open Circuit Voltage (Voc)	29.9V
Short Circuit Current (Isc)	6.82A

*NOCT (Nominal Operating Cell Temperature) : 49℃

Cells	
Number per Module	54

Module Characteristics	
Length × Width × Depth	1500mm(59.1in)×990mm(39.0in)×36mm(1.4in)
Weight	18.5kg(40.8lbs.)
Cable	(+)760mm(29.9in),(-)1840mm(72.4in)

Junction Box Characteristics	
Length × Width × Depth	100mm(3.9in)×108mm(4.3in)×15mm(0.6in)
IP Code	IP65

Others	
*Operating Temperature	−40℃ ~90℃
Maximum Fuse	15A

*This temperature is based on cell temperature.

Please contact our office for further information

KYOCERA

KYOCERA Corporation

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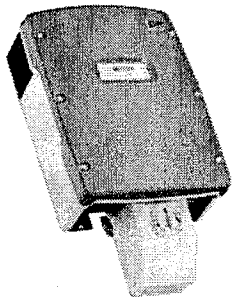
http://www.kyocera.com.cn/

● KYOCERA Korea Co., Ltd.
Diplomatic Center Room #406, 1376-1,
Seocho-2Dong, Seocho-Ku,Seoul, 137-072, Korea
TEL:(82)2-3463-3538 FAX:(82)2-3463-3539
http://www.kyocera.co.kr/

Kyocera reserves the right to modify these specifications without notice

SMA INVERTER

SMA SUNNY BOY 5000US



SUNNY BOY 5000US/6000US/7000US

The Sunny Boy 5000US, 6000US and Sunny Boy 7000US represent our larger units in the new "US" series of Sunny Boy string inverters. They are extremely robust inverters equally suited for large residential or commercial applications. Completely updated with our most advanced technology, they were designed specifically to meet the new IEEE 1547 requirements. The larger inverters of the new US series come with an integrated DC disconnect switch making installation even more cost-effective. They can even be configured for positive ground systems in the field making them more versatile than ever. Increased efficiency means better overall performance and shorter payback periods. The Sunny Boy 6000US and 7000US are compatible for use with the Sunny Tower 36 kW and 42 kW systems. Each comes with a standard ten year warranty and are engineered and built to provide years of trouble-free service.

Overview Technical Data Downloads

- CEC efficiency of up to 96 %
- 10 Year warranty standard, up to 20 years optional
- Certified to the new UL 1741/ IEEE 1547
- Integrated load-break rated DC disconnect switch
- Integrated fused series string combiner
- Sealed electronics enclosure and OptiCool
- Comprehensive SMA communications and data collection options
- Ideal for residential or light commercial applications
- Rugged cast aluminum outdoor rated enclosure

Solar Power Professional Search

Well informed and trained SMA contractors will be happy to help select the right product for you.

Postal Code

search

Home > Products > Grid-Tied Inverters > Sunny Boy > SUNNY BOY 5000US / 6000US / 7000US

SUNNY BOY 5000US / 6000US / 7000US

SUNNY BOY 3000US / 4000US

SUNNY BOY 700U

COMBI-SWITCH

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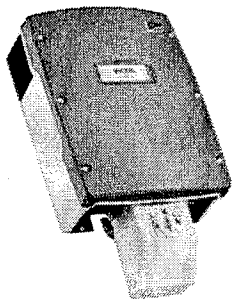

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Input Data (DC)	Sunny Boy 5000US	Sunny Boy 6000US	Sunny Boy 7000US
Recommended Max. PV Power (Module STC)	6250 W	7500 W	8750 W
Max. DC Voltage	600 V	600 V	600 V
Peak Power Tracking Voltage	250 – 480 V	250 – 480 V	250 – 480 V
DC Max. Input Current	21 A	25 A	30 A
Number of Fused String Inputs	3 (inverter), 4 x 15 A (DC disconnect)	3 (inverter), 4 x 15 A (DC disconnect)	3 (inverter), 4 x 15 A (DC disconnect)
PV Start Voltage (adjustable)	300 V	300 V	300 V
Output (AC)			
AC Nominal Power	5000 W	6000 W	7000 W
AC Maximum Output Power	5000 W	6000 W	7000 W
AC Maximum Output Current(@ 208, 240, 277 V)	24 A, 21 A, 18 A	29 A, 25 A, 22 A	34 A, 29 A, 25 A
AC Nominal Voltage / Range	183 – 229 V @ 208 V, 211 – 264 V @ 240 V, 244 – 305 V @ 277 V	183 – 229 V @ 208 V, 211 – 264 V @ 240 V, 244 – 305 V @ 277 V	183 – 229 V @ 208 V, 211 – 264 V @ 240 V, 244 – 305 V @ 277
AC Frequency / Range	60 Hz / 59.3 – 60.5 Hz	60 Hz / 59.3 – 60.5 Hz	60 Hz / 59.3 – 60.5 Hz
Power Factor	0.99 @ nominal power	0.99 @ nominal power	0.99 @ nominal power
Efficiency			
Peak Inverter Efficiency	96.8 %	97 %	97.1%
CEC Weighted Efficiency	95.5 %	95.5 %/95.5 %/96%	95.5 %/96 %/96%
Mechanical Data			
Dimensions W x H x D in Inches	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5	18.4 x 24.1 x 9.5
Weight / Shipping Weight	141 lbs / 148 lbs	141 lbs / 148 lbs	141 lbs / 148 lbs
Ambient Temperature Range	-13 to +113 °F	-13 to +113 °F	-13 to +113 °F
Power Consumption: standby / nighttime	< 7 W / 0.1 W	< 7 W / 0.1 W	< 7 W / 0.1 W
Topology	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave	Low frequency transformer, true sinewave
Cooling Concept	OptiCool, forced active cooling	OptiCool, forced active cooling	OptiCool, forced active cooling

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search

SMA Factory Warranty

10 Year Warranty

A ten year warranty applies to the following products: Sunny Boy SB700US, SB3000US, SB4000US, SB5000US, SB6000US, and SB7000US.

5 Year Warranty

A five year warranty applies to the following products: Sunny Boy SB700U, SB1100U, SWR1800U, SWR2100U, SWR2500U, SB3300U, SB3800U, SB6000U, SI4248, SI5048 and Windy Boy. A five year warranty also applies to Sunny Boy Control (Light Plus), Sunny Beam, Sunny WebBox, Sunny Matrix, Sunny Sensor Box, purchased after April 1, 2005.

2 Year Warranty

The two year warranty applies to the following products: Combiner Boxes, Sunny Boy Control (Light Plus), Sunny Beam, Sunny WebBox, Sunny Matrix, Sunny Sensor Box, purchased before April 1, 2005.

Extended Warranty

For the following devices you can acquire an extension of 5 or 10 years on the SMA factory warranty, from the date of the original warranty period.

5 Year Extended Warranty:	❑ Sunny Boy 3000US/4000US	$500
	❑ Sunny Boy 5000US/6000US/7000US	$750
10 Year Extended Warranty:	❑ Sunny Boy 3000US/4000US	$1,000
	❑ Sunny Boy 5000US/6000US/7000US	$1,500

Please contact the SMA service hotline for more details at 1 916 625 0870 or by fax 1 916 625 0871.

The SMA factory warranty covers any repair or replacement part costs incurred during the agreed period, beginning on the device's purchase date, subject to the conditions listed below. This is not associated with the durability warranty.

SMA America, Inc.
4031 Alvis Court, Rocklin, CA 95677
+1 916 625 0870 Fax +1 916 625 0871
www.SMA-America.com

SMA WEBBOX

SMA SUNNY WEBBOX
WITH RS485 COMMUNICATION CARD

SUNNY WEBBOX

The Sunny WebBox allows users to access their system performance data anytime – from anywhere in the world. The Sunny WebBox can interface with up to 50 Sunny Boy inverters and automatically posts their performance data to SMA's Web – based portal called Sunny Portal. By logging onto Sunny Portal, users can see their current and historical system performance data displayed graphically.

The Sunny Portal is a free service provided by SMA. The Sunny WebBox can communicate via Ethernet or an internal analog modem. The data collected is stored in common file formats for use in spread sheets, graphs or other websites.

Overview Technical Data Firmware Release Notes Downloads

The Sunny WebBox can be a very useful tool for installers as well. Installers can keep watch on new installations making sure that they are operating as specified. For new home construction, entire blocks of homes can be monitored by a single Sunny WebBox allowing both the system owners and installers a way to monitor the performance of the systems. This is also an excellent tool for demonstration systems. In addition, it provides a method for service personnel to receive prior notice to any potential issues or to check the status of a system before traveling to the site.

The Sunny WebBox provides an elegant solution to many of the industry's communications needs and is a welcome addition to the SMA family of products.

- System Access from any Web browser - anywhere in the world
- Recording of daily, monthly and annual energy yield via Sunny Portal
- Remote plant diagnosis
- Remote system configuration
- Automatic data transfer at chosen intervals
- Data storage and display via Ethernet
- Compatible with all SMA inverters
- Low power consumption

Solar Power Professional Search

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searches

Home > Products > Monitoring Systems > SUNNY WEBBOX

Monitoring Systems

SUNNY PORTAL

SUNNY BEAM with Bluetooth

SUNNY WEBBOX

SUNNY SENSORBOX

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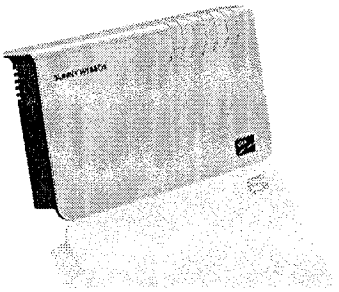

SUNNY WEBBOX

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The Sunny Portal is a free service provided by SMA. The Sunny WebBox can communicate via Ethernet or an internal analog modem. The data collected is stored in common file formats for use in spread sheets, graphs or other websites.

Overview Technical Data Firmware Release Notes Downloads

Interfaces	Sunny WebBox
Inverter Communication	RS485 (up to 50 inverters, max. 4000 ft. cable); Ethernet (only Sunny Central Communication)
Modem for Sunny Portal	internal analog modem (optional)
Ethernet	10 / 100 MBit, connection to the LAN network, Sunny Portal
Memory extension	
SD card	up to 2 GB
Mechanical data	
Width / height / depth in inches	8.85 / 5.11 / 2.25
Weight	1.65 lbs
Power supply	
Plug-in Power Supply	115 – 230 V 50 / 60 Hz
Power consumption	typ. 4 W / max. 12 W
Conditions for Operation	
Ambient temperature	-4 °F to 131 °F
Relative air humidity	5 % to 95 %
General Data	
Status Display	integrated LEDs
Installation Options	wall mounting, tabletop device

Solar Power Professional Search

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Home > Products > Monitoring Systems > SUNNY WEBBOX

Monitoring Systems

SUNNY PORTAL
SUNNY BEAM with Bluetooth
SUNNY WEBBOX
SUNNY SENSORBOX

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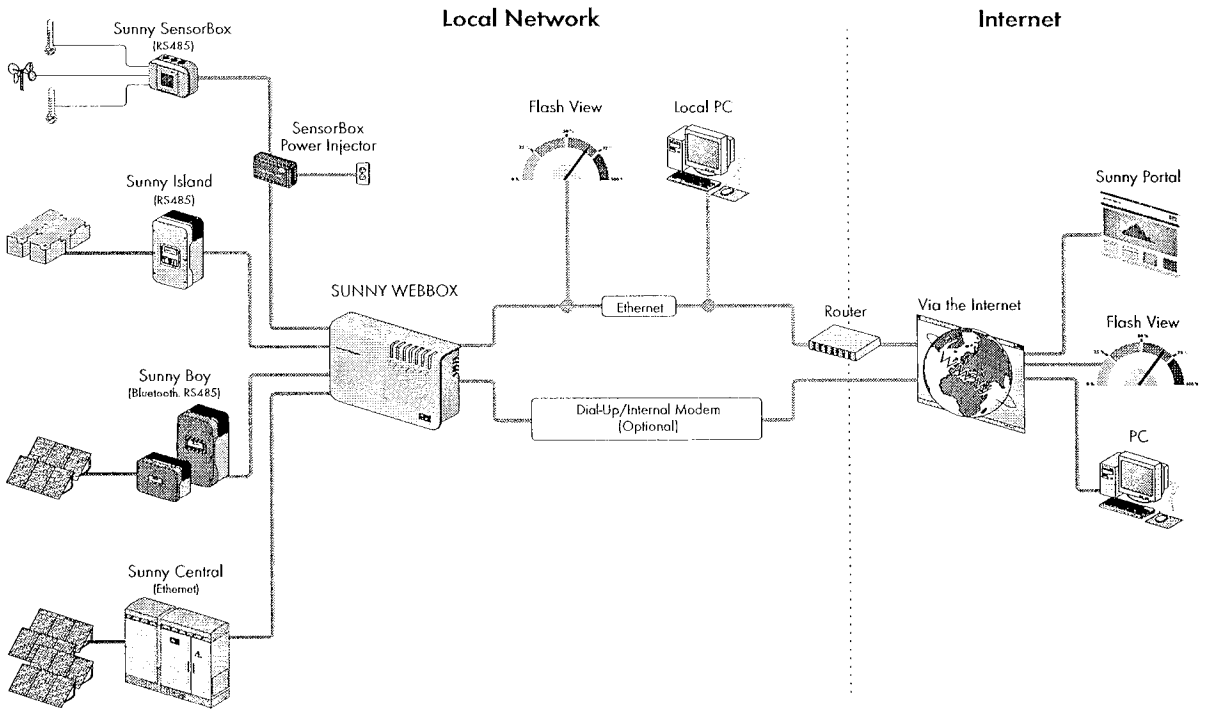
Technical Data
SUNNY WEBBOX

	SUNNY WEBBOX
Inverter Communication	RS485 (up to 50 inverters, max. 4000 ft cable) Ethernet (only Sunny Central Communication)
Modem for Sunny Portal Interface (optional)	internal analog modem
Ethernet Interface	10 / 100 MB, connection to LAN, Sunny Portal
SD Card Data Storage	up to 2 GB
Status Display	integrated LEDs
Power Supply	115 - 230 V, 50 / 60 Hz
Plug-In Power Consumption	typ. 4 W / max. 12 W
Operating Ambient Temperature	-4 to 131° F
Operating Relative Air Humidity	5% to 95%
Dimensions (W x H x D) in inches	8.85 x 2.25 x 5.11
Weight	1.65 lbs
Installation Options	wall mounting, tabletop device



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www.SMA-America.com
Phone 916 625 0870
Toll Free 888 4 SMA USA

SMA America, Inc.

SMA Factory Warranty

10 Year Warranty

A ten year warranty applies to the following products: Sunny Boy SB700U purchased after October 1st 2007, SB3000US, SB4000US, SB5000US, SB6000US, SB7000US.

5 Year Warranty

A five year warranty applies to the following products: Sunny Boy SB700U purchased before October 1st 2007, SB1100U, SB1800U, SB2100U, SB2500U, SB3300U, SB3800U, and Windy Boy. A five year warranty also applies to Sunny Beam, Sunny WebBox, Sunny Matrix, Sunny Sensor Box, Sunny Boy Control (Light Plus) purchased after April 1st, 2005.

2 Year Warranty

The two year warranty applies to the following products: Sunny Beam, Sunny WebBox, Sunny Matrix, Sunny Sensor Box, Sunny Boy Control (Light Plus) purchased before April 1st, 2005.

The SMA factory warranty covers any repair or replacement part costs incurred during the agreed period, beginning on the device's purchase date, subject to the conditions listed below. This is not associated with the durability warranty.

For devices purchased after April 1st, 2005, you can acquire an extension of the SMA factory warranty, valid for 10 years from the date of purchase. The prices are based on the respective SMA price list valid at the time the purchase contract was signed. Please contact the SMA Technical Service Line for more details at +1 530 273 4895 or by fax at +1 530 274 7271

Warranty Conditions

If a device becomes defective during the relevant SMA factory warranty period, one of the following services, as selected by SMA, will be performed at no charge for materials or labor costs:

- repair at SMA, or
- repair on site, or
- exchange for a replacement device of equivalent value according to model and age.

In this case, the remainder of the warranty entitlement will be transferred to the replacement device. In such an event, you would not receive a new certificate, as your entitlement is documented at SMA.

Upon acquisition of a warranty extension after expiry of the standard warranty period, the extension only begins after a grace period of four weeks after receipt of the warranty extension order at SMA. Any repairs during this period are at the customer's expense.

For determination of warranty entitlement, please submit a copy of the purchase receipt, or a copy of the warranty certificate, and if applicable, evidence of the warranty extension. The type plate on the device must be completely legible. Otherwise, SMA is entitled to refuse to provide warranty services.

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Tel. +1 530 273 4895
Fax +1 530 274 7271

GU_SBUS-ZUS082310 1/2

Please report defective devices to our SMA Technical Service Line at +1 530 273 4895 or by fax at +1 530 274 7271, providing a brief description of the fault. On workdays, we generally send an equivalent replacement device, packaged appropriately for transport, within 48 hours. The defective device is to be packed in this transport packaging for return transport to SMA. If the warranty applies, and if SMA has a branch, or service partner, in the country in which the device is operated, the transport costs are covered by SMA.

Exclusion of Liability

Warranty claims and liability for direct or indirect damage are excluded if arising from:

- transport damage,
- incorrect installation or commissioning,
- failure to observe the maintenance regulations and intervals,
- modifications, changes or attempted repairs,
- incorrect use or inappropriate operation,
- insufficient ventilation of the device
- failure to observe the applicable safety regulations,
- force majeure (e.g. lightning, overvoltage, storm, fire), or
- cosmetic shortcomings which do not influence the supply of energy.

Further-reaching or additional claims due to direct or indirect damage, especially claims for compensation for damages due to loss of profits or due to costs arising from disassembly and mounting, are excluded if no legally mandatory liability applies.

In addition, our general terms and conditions of delivery apply. They can be downloaded from www.sma-america.com. If requested, we can also send you a copy of our general terms and conditions of delivery. Please contact our SMA Technical Service Line at +1 530 273 4895, ext. 100.

Mounting Location In-/Outdoor (NEMA 3R)	Included/Included	Included/Included	Included/Included
Features			
LCD-Display	included	included	included
Lid Color: aluminum/red/blue/yellow	included/optional/ optional/optional	included/optional/ optional/optional	included/optional/ optional/optional
Communication: RS485 / Wireless	optional/optional	optional/optional	optional/optional
Warranty: 10-year	included	included	included
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	included	included	included

Home > Products > Grid-Tied Inverters > Sunny Boy > SUNNY BOY 5000US / 6000US / 7000US

SUNNY BOY 5000US / 6000US / 7000US

SUNNY BOY 3000US / 4000US

SUNNY BOY 700U

COMBI-SWITCH

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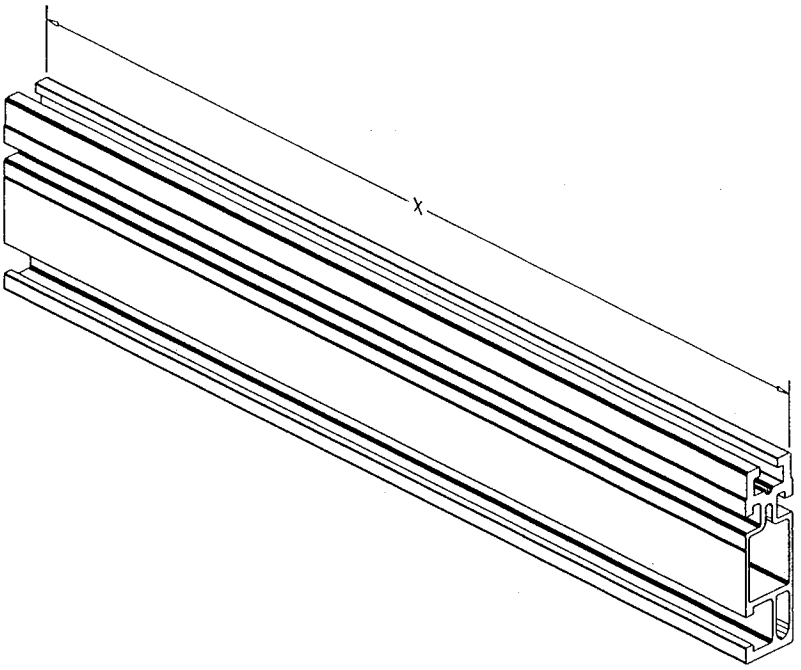
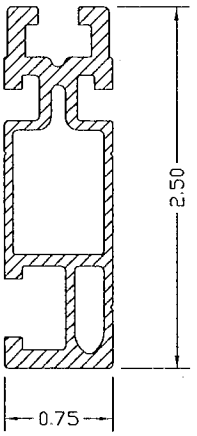
UNIRAC

UNIRAC SOLAR MOUNT
PART# 300115
LENGTH 216”





UNIRAC®

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SolarMount

Standard Rail

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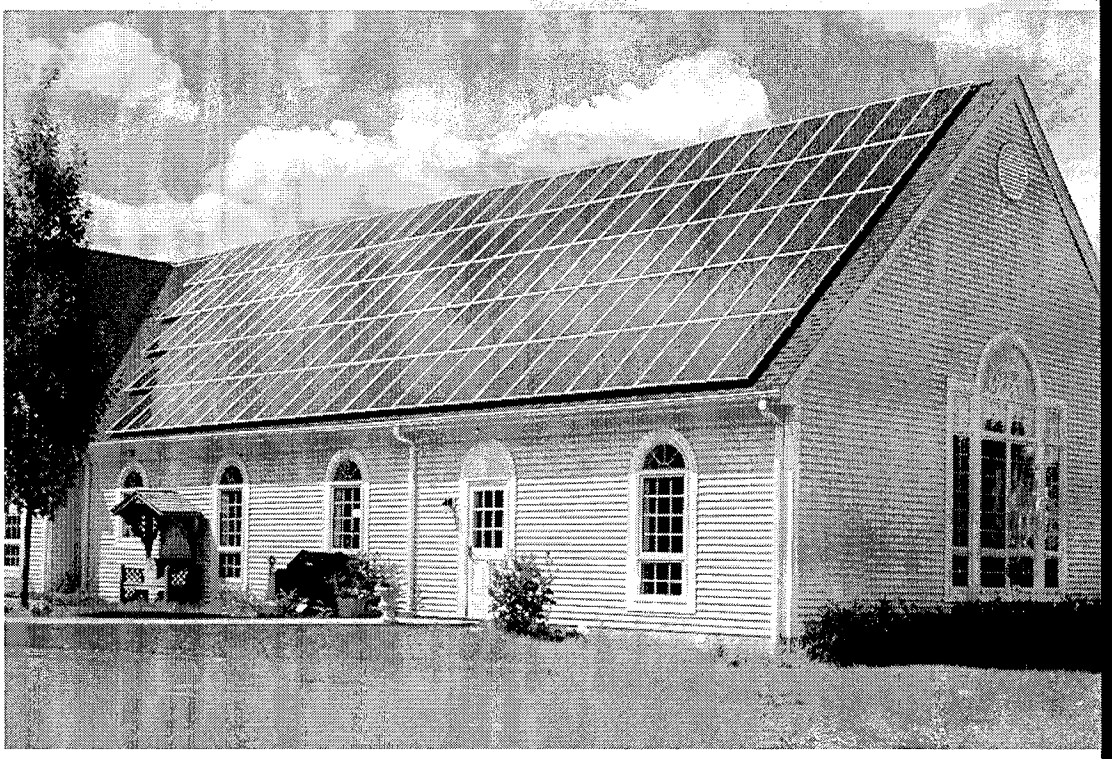
ALBUQUERQUE, NM 87102 USA
PHONE 505.242.6411
UNIRAC.COM

UNIRAC–300001

SOLARMOUNT™

Code-Compliant Installation Manual 227.2

U.S. Des. Patent No. D496,248S, D496,249S. Other patents pending.



Unirac Code-Compliant Installation Manual

Table of Contents

UNIRAC®

Bright Thinking in Solar

Pub 090629-2cc
June 2009

Unirac welcomes input concerning the accuracy and user-friendliness of this publication Please write to **publications@unirac.com.**

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i. Installer's Responsibilities

Please review this manual thoroughly before installing your SolarMount system.

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

SolarMount 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 SolarMount products (page 26).

SolarMount is much more than a product.

It's a system of engineered components that can be assembled into a wide variety of PV mounting structures. With SolarMount you'll be able to solve virtually any PV module mounting challenge.

It's also a system of technical support: complete installation and code compliance documentation, an on-line SolarMount Estimator, person-to-person customer service, and design assistance to help you solve the toughest challenges.

Which is why SolarMount is PV's most widely used mounting system.

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 lag screws have adequate pullout strength and shear capacities as installed;
- Verifying the strength of any alternate mounting used in lieu of the lag screws;
- Maintaining the waterproof integrity of the roof, including selection of appropriate flashing;
- 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. 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. For purposes of this document, 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, no tilt, SolarMount Series 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 panels.

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 I. Lower design wind loads may be obtained by applying Method II from ASCE 7-05. Consult with a licensed engineer if you want to use Method II procedures.

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

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

$p_{net}\ (psf)$ = *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 you are installing the pv system according to Figure 2, page 5.

Roof Zone Setback Length = a (ft)

Roof Pitch (degrees)

Exposure Category

[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 maps 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 rail. That area is the Effective Wind Area.

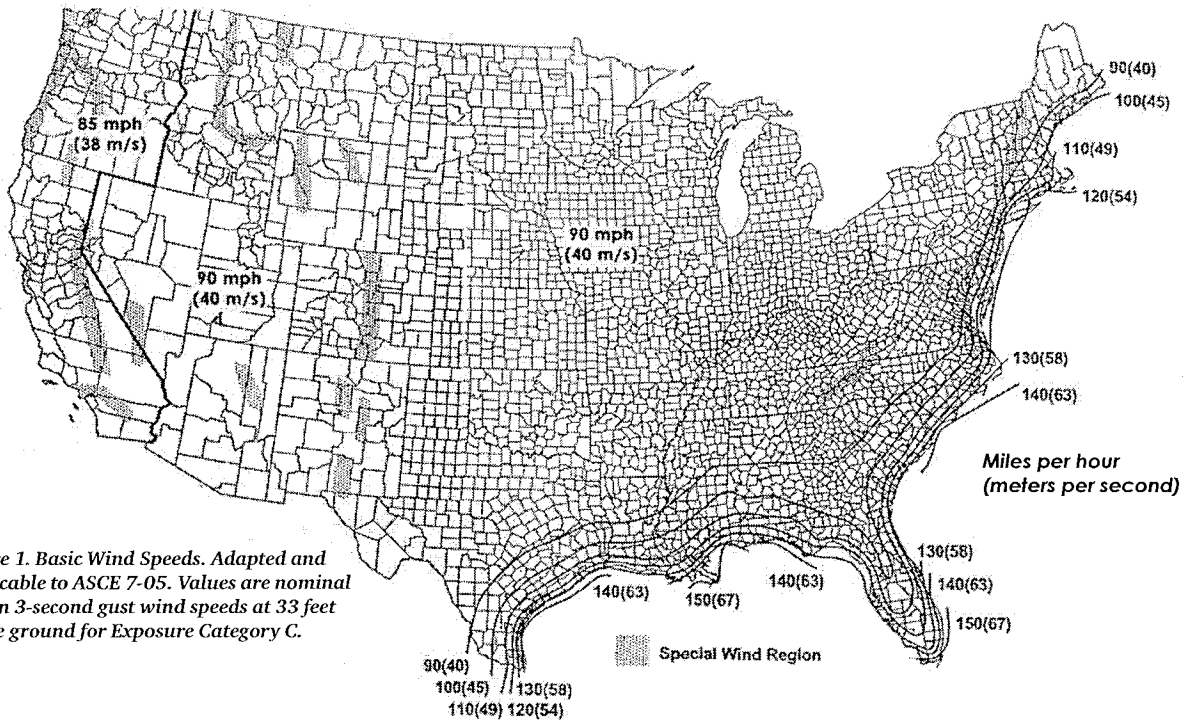


Figure 1. Basic Wind Speeds. Adapted and applicable to ASCE 7-05. Values are nominal design 3-second gust wind speeds at 33 feet above ground for Exposure Category C.

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.

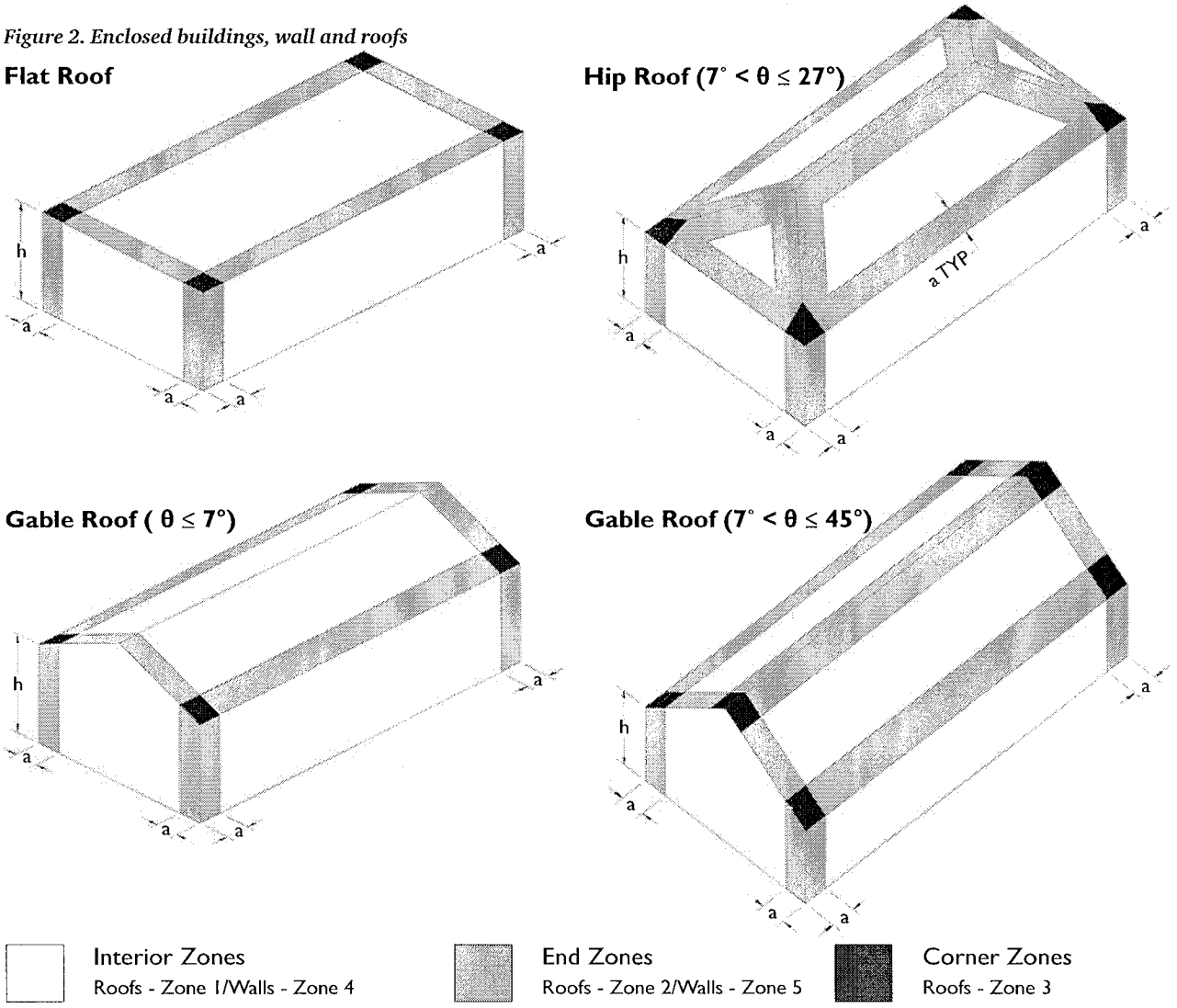
Roof Height (ft)	*Least Horizontal Dimension (ft)*																		
	10	***15***	***20***	***25***	***30***	***40***	***50***	***60***	***70***	***80***	***90***	***100***	***125***	***150***	***175***	***200***	***300***	***400***	***500***
10	3	3	3	3	3	4	4	4	4	4	4	4	5	6	7	8	12	16	20
15	3	3	3	3	3	4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

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 *Effective Wind Area* (Step 2), *Roof Zone Location* (Step 3), and *Basic Wind Speed* (Step 1), 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, use Table 3, page 7.

Both downforce and uplift pressures must be considered in overall design. Refer to Section II, Step 1 for applying downforce and uplift pressures. Positive values are acting toward the surface. Negative values are acting away from the surface.

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

			Basic Wind Speed,V (mph)															
			90		100		110		120		130		140		150		170	
	Zone	Effective Wind Area (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 45degrees	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.

Also 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:

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

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 SolarMount Series rail, rail span and foot spacing.

Table 4. Adjustment Factor (λ) for Roof Height & Exposure Category

Mean roof height (ft)	Exposure B	Exposure C	Exposure 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}	×		5	
Adjustment factor for height and exposure category	λ	×		7	Table 4
Importance Factor	I	×		8	Table 5
Total Design Wind Load	p_{net}		psf	9	

Table 6. Occupancy Category Importance Factor

Category	*Category Desicription*	*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 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 more than 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. 77

Part II. Procedure to Select Rail Span and Rail Type

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

The procedure to determine the Unirac SolarMount series rail type and rail 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 beam calculations, equations and assumptions.

In 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 rail span and footing 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 5 psf, see your Unirac distributor, a local structural engineer or contact Unirac.

The following procedure will guide you in selecting a Unirac rail 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 (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 the load cases. Use the maximum absolute value of the three downforce cases and the uplift case for sizing the rail. 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)

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

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

$P\ (psf) = 0.6D + 1.0p_{net}$ (uplift)

D = *Dead Load (psf)*

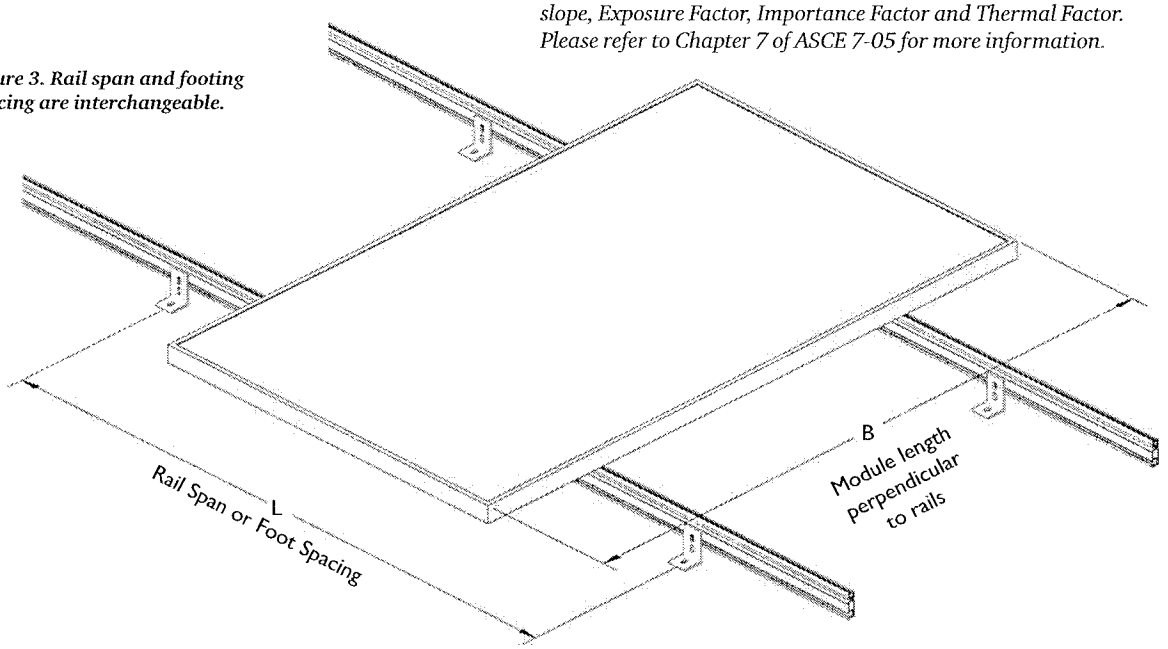
S = *Snow Load (psf)*

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. Rail span and footing spacing are interchangeable.



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

Table 7. ASCE 7 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 rail, 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 rails.

$$w = PB/2$$

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

B = Module Length Perpendicular to Rails (ft)

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

Step 3: Determine *Rail Span/ L-Foot Spacing*

Using the *distributed load, w*, from Part II, **Step 2**, look up the *allowable spans, L*, for each Unirac rail type, SolarMount (SM) and SolarMount Heavy Duty (HD).

There are two tables, L-Foot SolarMount Series Rail Span Table and Double L-Foot SolarMount Series Rail Span Table. The L-Foot SolarMount Series Rail Span Table uses a single L-foot connection to the roof, wall or stand-off. The point load connection from the rail to the L-foot can be increased by using a double L-foot in the installation. Please refer to the **Part III** for more installation information.

Table 8. L-Foot SolarMount Series Rail Span

SM - SolarMount **HD - SolarMount Heavy Duty**

Span	*w = Distributed Load (plf)*																	
(ft)	20	25	30	40	50	60	80	100	120	140	160	180	200	220	240	260	280	300
2	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
2.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
3	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM		
3.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM				
4	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD						
4.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD							
5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD								
5.5	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD								
6	SM	SM	SM	SM	SM	SM	HD	HD	HD									
6.5	SM	SM	SM	SM	SM	SM	HD	HD	HD									
7	SM	SM	SM	SM	SM	HD	HD	HD										
7.5	SM	SM	SM	SM	SM	HD	HD	HD										
8	SM	SM	SM	SM	HD	HD	HD											
8.5	SM	SM	SM	HD	HD	HD	HD											
9	SM	SM	SM	HD	HD	HD	HD											
9.5	SM	SM	SM	HD	HD	HD												
10	SM	SM	HD	HD	HD	HD												
10.5	SM	SM	HD	HD	HD	HD												
11	SM	HD	HD	HD	HD													
11.5	SM	HD	HD	HD	HD													
12	HD	HD	HD	HD														
12.5	HD	HD	HD	HD														
13	HD	HD	HD	HD														
13.5	HD	HD	HD															
14	HD	HD	HD															
14.5	HD	HD	HD															
15	HD	HD	HD															
15.5	HD	HD																
16	HD	HD																
17	HD																	

Table 9. Double L-Foot SolarMount Series Rail Span

SM - SolarMount **HD - SolarMount Heavy Duty**

Span (ft)	w = Distributed Load (plf)																	
	20	25	30	40	50	60	80	100	120	140	160	180	200	220	240	260	280	300
2	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
2.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
3	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM
3.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD
4	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD	
4.5	SM	SM	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD		
5	SM	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD				
5.5	SM	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD					
6	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD	HD						
6.5	SM	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD							
7	SM	SM	SM	SM	SM	HD	HD	HD	HD	HD								
7.5	SM	SM	SM	SM	SM	HD	HD	HD	HD									
8	SM	SM	SM	SM	HD	HD	HD	HD										
8.5	SM	SM	SM	HD	HD	HD	HD											
9	SM	SM	SM	HD	HD	HD	HD											
9.5	SM	SM	SM	HD	HD	HD												
10	SM	SM	HD	HD	HD	HD												
10.5	SM	SM	HD	HD	HD	HD												
11	SM	HD	HD	HD	HD													
11.5	SM	HD	HD	HD	HD													
12	HD	HD	HD	HD														
12.5	HD	HD	HD	HD														
13	HD	HD	HD	HD														
13.5	HD	HD	HD															
14	HD	HD	HD															
14.5	HD	HD	HD															
15	HD	HD	HD															
15.5	HD	HD																
16	HD	HD																
17	HD																	

Step 4: Select Rail Type

Selecting a span and rail type affects the price of your installation. Longer spans produce fewer wall or roof penetrations. However, longer spans create higher point load forces on the building structure. A point load force is the amount of force transferred to the building structure at each connection.

It is the installer's responsibility to verify that the building structure is strong enough to support the point load forces.

Step 5: Determine the Downforce *Point Load, R (lbs)*, at each connection based on rail 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 *Rail Span, L (ft)* (Step 3) and the *Module Length Perpendicular to the Rails, B (ft)* divided by two.

$$R\ (lbs) = PLB/2$$

R = *Point Load (lbs)*

P = *Total Design Load (psf)*

L = *Rail Span (ft)*

B = *Module Length Perpendicular to Rails (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 Step 5.

Table 10. Downforce Point Load Calculation

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

Step 6: Determine the Uplift Point Load, R (lbs), at each connection based on rail span

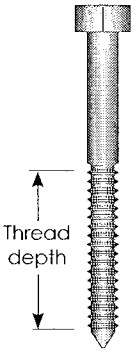
You must also consider the Uplift Point Load, R (lbs), to determine the required lag bolt attachment to the roof (building) structure.

Table 11. Uplift Point Load Calculation

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

Table 12. Lag pull-out (withdrawal) capacities (lbs) in typical roof lumber (ASD)

		Lag screw specifications
	Specific gravity	*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.*

Use Table 12 to select a lag bolt size and embedment depth to satisfy your Uplift Point Load Force, R (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 5 and Step 6.

Part III. Installing SolarMount

The Unirac Code-Compliant Installation Instructions support applications for building permits for photovoltaic arrays using Unirac PV module mounting systems.

This manual, SolarMount Planning and Assembly, governs installations using the SolarMount and SolarMount HD (Heavy Duty) systems.

[3.1.] SolarMount® rail components

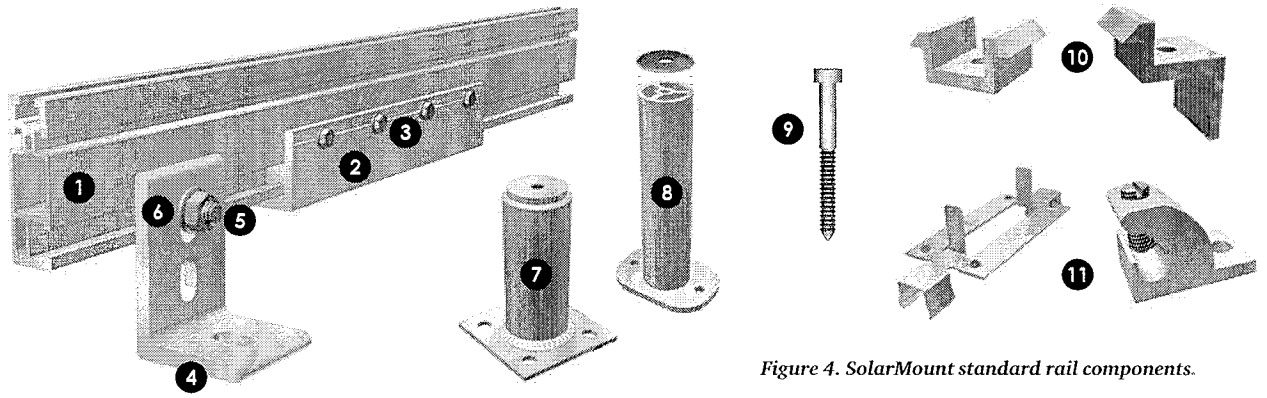


Figure 4. SolarMount standard rail components.

1. **Rail** – Supports PV modules. Use two per row of modules. 6105-T5 aluminum extrusion, anodized.

2. **Rail splice** – Joins and aligns rail sections into single length of rail. It can form either a rigid or thermal expansion joint, 8 inches long, predrilled. 6105-T5 aluminum extrusion, anodized.

3. **Self-drilling screw** – (No. 10 x ¾") – Use 4 per rigid splice or 2 per expansion joint. Galvanized steel.

4. **L-foot** – Use to secure rails either through roofing material to building structure or standoffs. Refer to loading tables for spacing. Note: Please contact Unirac for use and specification of double L-foot.

5. **L-foot bolt** (3/8" x ¾") – Use one per L-foot to secure rail to L-foot. 18-8A2 stainless steel.

6. **Flange nut** (3/8 ") – Use one per L-foot to secure rail to L-foot. 18-8A2 stainless steel.

7. **Flattop standoff** (optional) (3/8 ") – Use standoffs to increase the height of the array above the surface of the roof or to allow for the use of flashings. Use one per L-foot. One piece: Service Condition 4 (very severe) zinc-plated-welded steel. Includes 3/8 " x ¼" bolt with lock washer for attaching L-foot. Flashings: Use one per standoff. Unirac offers appropriate flashings for both standoff types.
Note: There is also a flange type standoff that does not require an L-foot.

8. **Aluminum two-peice standoff** (optional) (4" and 7") – Use one per L-foot. Two-piece: 6105-T5 aluminum extrusion. Includes $^{3}/_{8}$" x $^{3}/_{4}$" serrated flange bolt with EPDM washer for attaching L-foot, and two $^{5}/_{16}$" lag bolts.

9. **Lag screw for L-foot** (5/16") – Attaches standoff to rafter.

10. **Top Mounting Clamps**

11. **Top Mounting Grounding Clips and Lugs**

Installer supplied materials:

- **Lag screw for L-foot** – Attaches L-foot or standoff to rafter. Determine the length and diameter based on pull-out values. If lag screw head is exposed to elements, use stainless steel. Under flashings, zinc plated hardware is adequate.

- **Waterproof roofing sealant** – Use a sealant appropriate to your roofing material. Consult with the company currently providing warranty of roofing.

[3.2.] Installing SolarMount with top mounting clamps

This section covers SolarMount rack assembly where the installer has elected to use top mounting clamps to secure modules to the rails. It details the procedure for flush mounting SolarMount systems to a pitched roof.

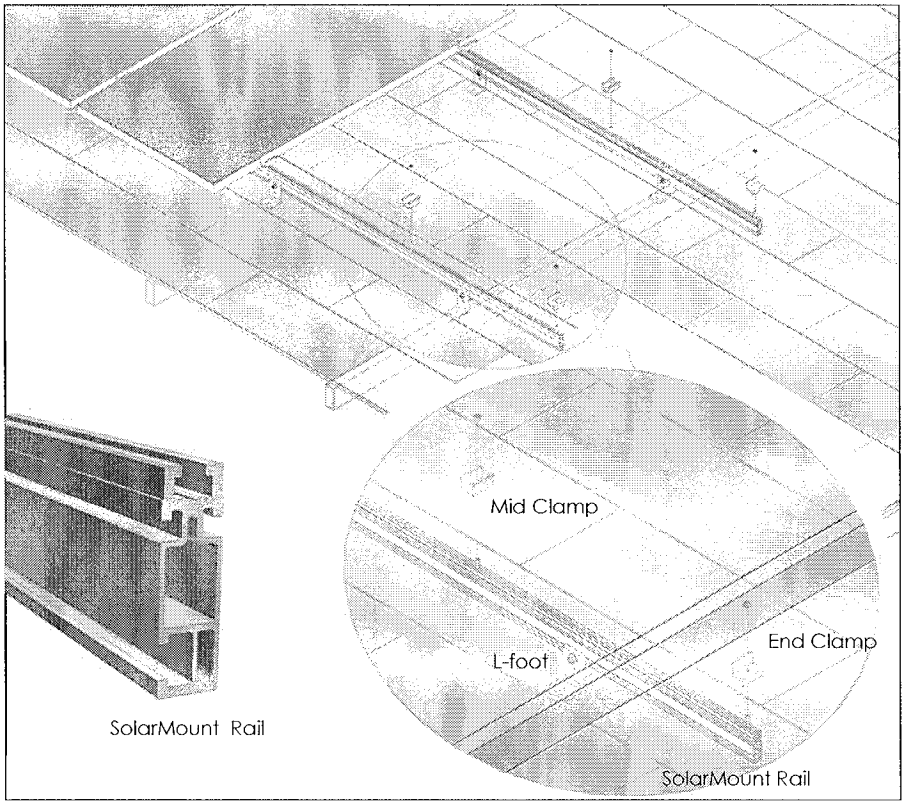


Figure 5. Exploded view of a flushmount installation mounted with L-feet.

Table 14. Clamp kit part quantities

Modules	End clamps	Mid clamps	¼" module clamp bolts	¼"x ⅝" safety bolts	¼" flange nuts
2	4	2	6	2	8
3	4	4	8	2	10
4	4	6	10	2	12
5	4	8	12	2	14
6	4	10	14	2	16
7	4	12	16	2	18
8	4	14	18	2	20

Table 15. Wrenches and torque

	Wrench size	Recommended torque (ft-lbs)
¼" hardware	7/16"	5 - 10 ⚠
⅜" hardware	9/16"	

Torques are not designated for use with wood connectors

⚠ ***All top down clamps must be installed with anti-seize to prevent galling and provide uniformity in clamp load. UniRac Inc recommends Silver Grade LocTite Anti-Seize Item numbers: 38181, 80209,76732,76759,76764, 80206, and 76775, or equivalent. 1/4" - 20 hardware used in conjunction with top down clamps must be installed to 5 - 10 ft-lbs of torque. When using UGC-1, UGC-2, WEEB 9.5 and WEEB 6.7, 1/4" - 20 hardware must be installed to 10 ft-lbs or torque. Additionally, when used with a top down clamp, the module frame cross section must be boxed shaped as opposed to a single, l-shaped member. Please refer to installation supplement* **910: Galling and Its Prevention** *for more information on galling and anti-seize and installation manual* **225: Top Mounting Unirac Grounding Clips and WEEBLugs** *for more information on Grounding Clips."***

[3.2.1] Planning your SolarMount® installations

The installation can be laid out with rails parallel to the rafters or perpendicular to the rafters. Note that SolarMount rails 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).

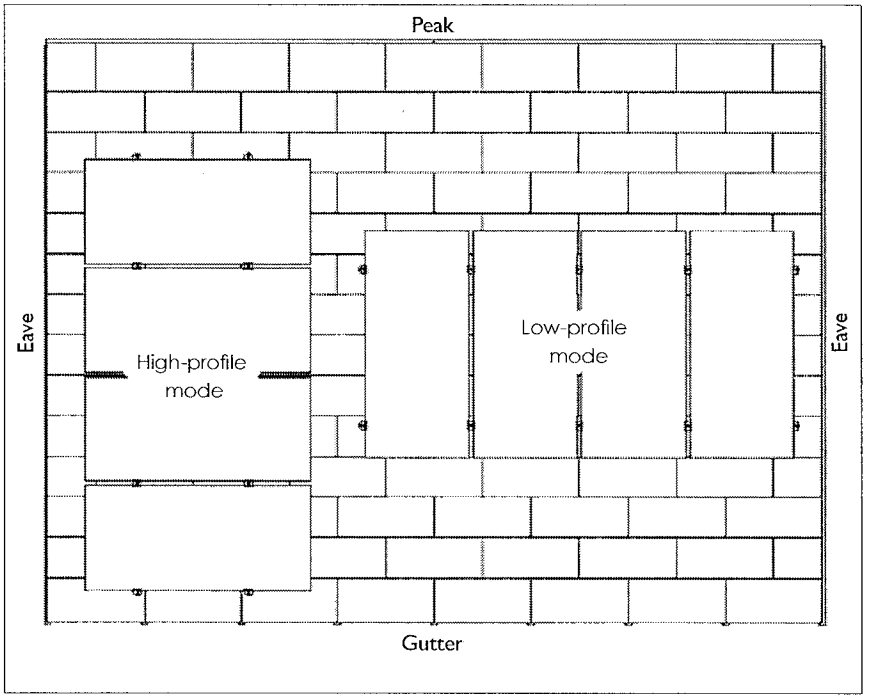


Figure 6. Rails may be placed parallel or perpendicular to rafters.

[3.2.2] Laying out L-feet

L-feet (Fig. 7) can be used for attachment through existing roofing material, such as asphalt shingles, sheathing or sheet metal to the building structure.

Use Figure 8 or 9 below to locate and mark the position of the L-feet lag screw holes within the installation area.

If multiple rows are to be installed adjacent to one another, it is not likely that each row will be centered above the rafters. Adjust as needed, following the guidelines in Figure 9 as closely as possible.

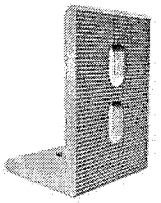


Figure 7

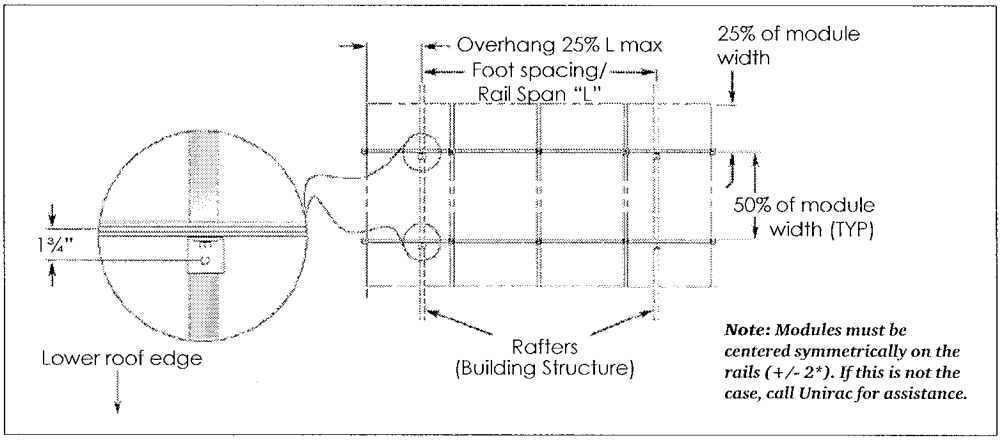


Figure 8. Layout with rails perpendicular to rafters.

Installing L-feet

Drill pilot holes through the roof into the center of the rafter at each L-foot lag screw hole location.

Squirt sealant into the hole, and on the shafts of the lag screws. Seal the underside of the L-feet with a suitable sealant. Consult with the company providing the roofing warranty.

Securely fasten the L-feet to the roof with the lag screws. Ensure that the L-feet face as shown in Figure 8 and 9. For greater ventilation, the preferred method is to place the single-slotted square side of the L-foot against the roof with the double-slotted side perpendicular to the roof. If the installer chooses to mount the L-foot with the long leg against the roof, the bolt slot closest to the bend must be used.

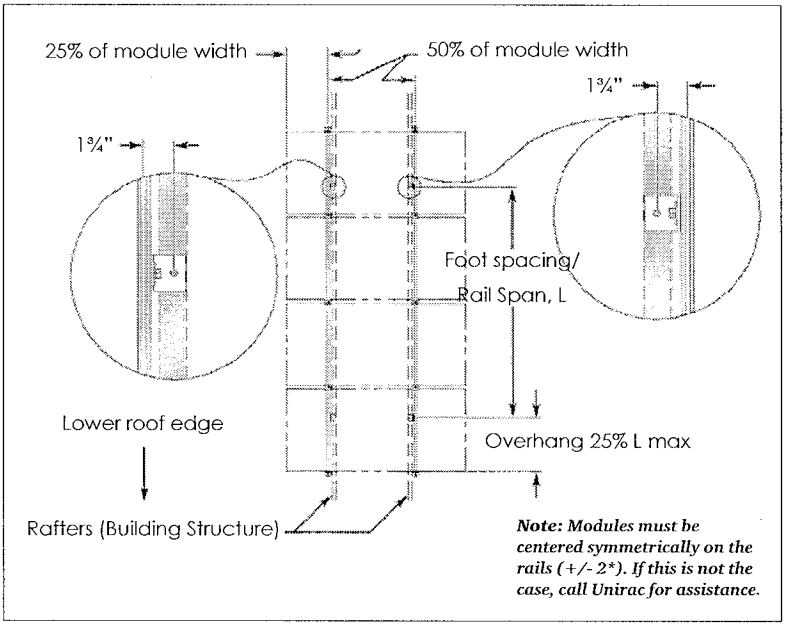


Figure 9. Layout with rails parallel to rafters.

[3.2.3] Laying out standoffs

Standoffs (Figure 10) are used to increase the height of the array above the surface of the roof. Pair each standoff with a flashing to seal the lag bolt penetrations to the roof.

Use Figure 11 or 12 to locate and mark the location of the standoff lag screw holes within the installation area.

Remove the tile or shake underneath each standoff location, exposing the roofing underlayment. Ensure that the standoff base lies flat on the underlayment, but remove no more material than required for the flashings to be installed properly.

The standoffs must be firmly attached to the building structure.

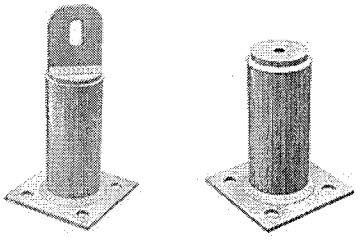
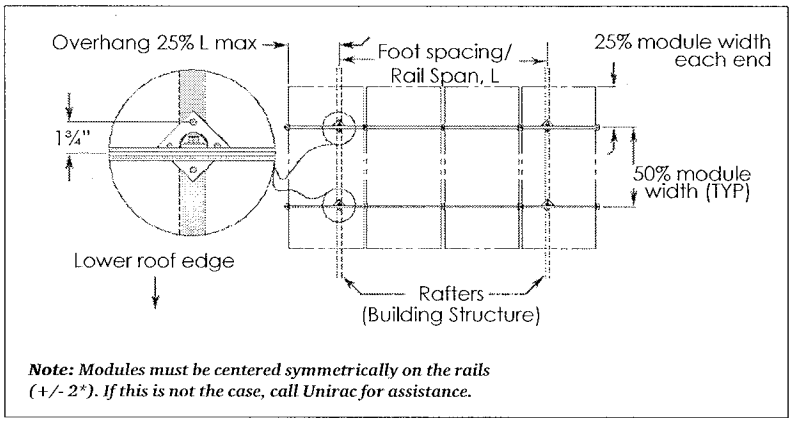
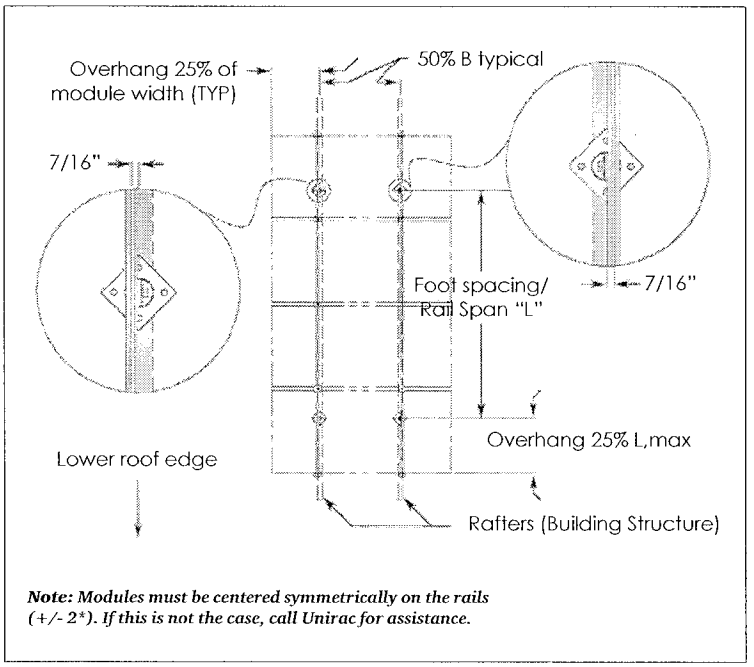


Figure 10. Raised flange standoff (left) and flat top standoff used in conjunction with an L-foot.



***Note:** Modules must be centered symmetrically on the rails (+/- 2*). If this is not the case, call Unirac for assistance.*

Figure 11. Layout with rails perpendicular to rafters.perpendicular to rafters.



***Note:** Modules must be centered symmetrically on the rails (+/- 2*). If this is not the case, call Unirac for assistance.*

Figure 12. Layout with rails parallel to rafters.

If multiple high-profile rows are to be installed adjacent to each other, it may not be possible for each row to be centered above the rafters. Adjust as needed, following the guidelines of Fig. 12 as closely as possible.

Installing standoffs

Drill 3/16 inch pilot holes through the underlayment into the center of the rafters at each standoff location. Securely fasten each standoff to the rafters with the two 5/16" lag screws.

Ensure that the standoffs face as shown in Figure 11 or 12.

Unirac steel standoffs (1 5/8 " O.D.) are designed for collared flashings available from Unirac. Aluminum two-piece standoffs (1 1/8 " O.D.) take all-metal flashings, also available from Unirac.

Install and seal flashings and standoffs using standard building practices or as the company providing roofing warranty directs.

[3.2.4] Installing SolarMount rails

Keep rail slots free of roofing grit or other debris. Foreign matter will cause bolts to bind as they slide in the slots.

Installing Splices. If your installation uses SolarMount splice bars, attach the rails together (Fig. 13) before mounting the rails to the footings. Use splice bars only with flush installations or those that use low-profile tilt legs.

Although structural, the joint is not as strong as the rail itself. A rail should always be supported by ***more than one*** footing on ***both*** sides of the splice. (Reference installation manual 908, Splices/Expansion Joints.)

If using more than one splice per rail, contact Unirac concerning thermal expansion issues.

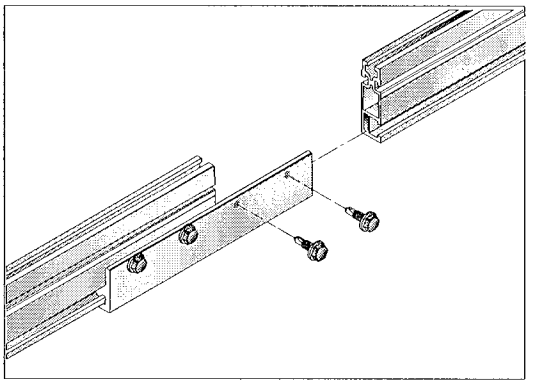


Figure 13. Splice bars slide into the footing bolt slots of SolarMount rail sections.

Mounting Rails on Footings. Rails may be attached to either of two mounting holes in the L-feet (Fig. 14). Mount in the lower hole for a low profile, more aesthetically pleasing installation. Mount in the upper hole for a higher profile, which will maximize airflow under the modules. This will cool them more and may enhance performance in hotter climates.

Slide the ⅜-inch mounting bolts into the footing bolt slots. Loosely attach the rails to the footings with the flange nuts.

Ensure that the rails are oriented to the footings as shown in Figure 8, 9, 11, or 12, whichever is appropriate.

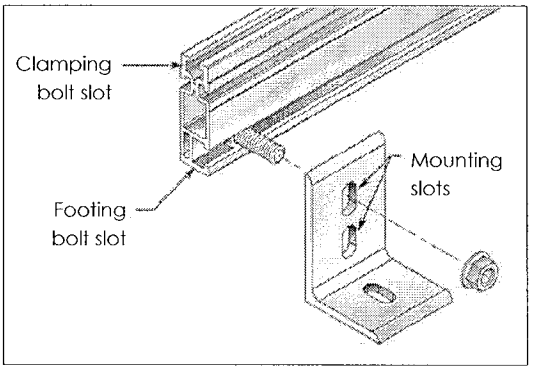


Figure 14. Foot-to-rail splice attachment

Aligning the Rail Ends. Align one pair of rail ends to the edge of the installation area (Fig. 15 or Fig. 16).

The opposite pair of rail ends will overhang the side of the installation area. Do not trim them off until the installation is complete.

If the rails are perpendicular to the rafters (Fig. 15), either end of the rails can be aligned, but the first module must be installed at the aligned end.

If the rails are parallel to the rafters (Fig. 16), the aligned end of the rails must face the lower edge of the roof. Securely tighten all hardware after alignment is complete (20 ft lbs).

Mount modules to the rails as soon as possible. Large temperature changes may bow the rails within a few hours if module placement is delayed.

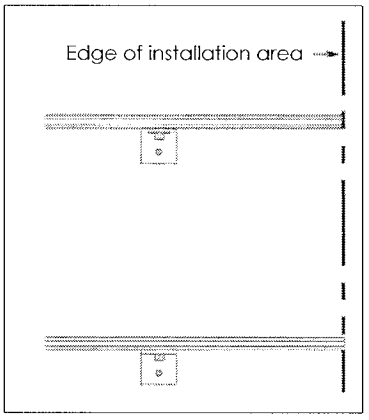


Figure 15. Rails perpendicular to the rafters.

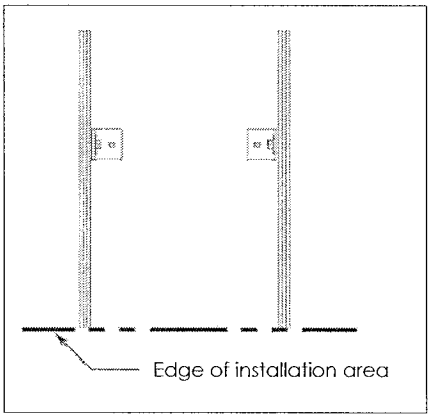


Figure 16. Rails parallel to the rafters.

[3.2.5] Installing the modules

Pre-wiring Modules. If modules are the Plug and Play type, no pre-wiring is required, and you can proceed directly to "Installing the First Module" below.

If modules have standard J-boxes, each module should be pre-wired with one end of the intermodule cable for ease of installation. For safety reasons, module pre-wiring should not be performed on the roof.

Leave covers off J-boxes. They will be installed when the modules are installed on the rails.

Installing the First Module. In high-profile installations, the safety bolt and flange nut must be fastened to the module bolt slot at the aligned (lower) end of each rail. It will prevent the lower end clamps and clamping bolts from sliding out of the rail slot during installation.

If there is a return cable to the inverter, connect it to the first module. Close the J-box cover. Secure the first module with T-bolts and end clamps at the aligned end of each rail. Allow half an inch between the rail ends and the end clamps (Fig.18). Finger tighten flange nuts, center and align the module as needed, and securely tighten the flange nuts (5-10 ft lbs).

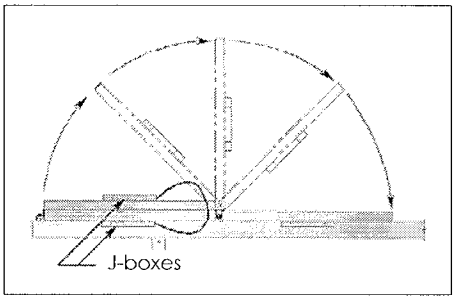


Figure 17

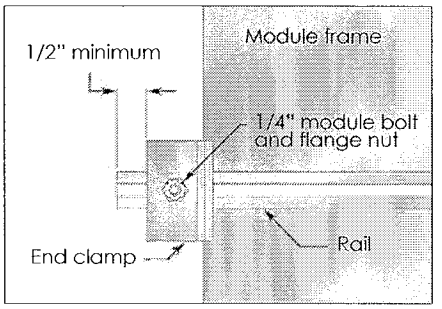


Figure 18

Installing the Other Modules. Lay the second module face down (glass to glass) on the first module. Connect intermodule cable to the second module and close the J-box cover. Turn the second module face up (Fig. 17). With T-bolts, mid-clamps and flange nuts, secure the adjacent sides of the first and second modules. Align the second module and securely tighten the flange nuts (Fig. 19).

For a neat installation, fasten wire management devices to rails with self-drilling screws.

Repeat the procedure until all modules are installed. Attach the outside edge of the last module to the rail with end clamps.

Trim off any excess rail, being careful not to cut into the roof. Allow half an inch between the end clamp and the end of the rail (Fig. 18).

Check that all flange nuts on T-bolts are torqued to 5-10 ft lbs.

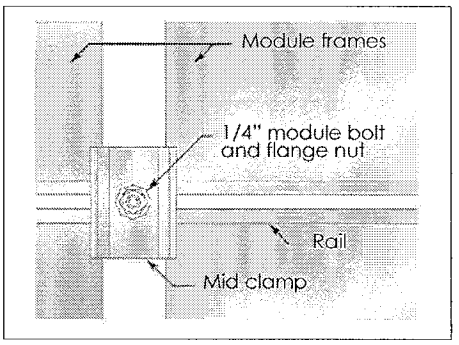


Figure 19

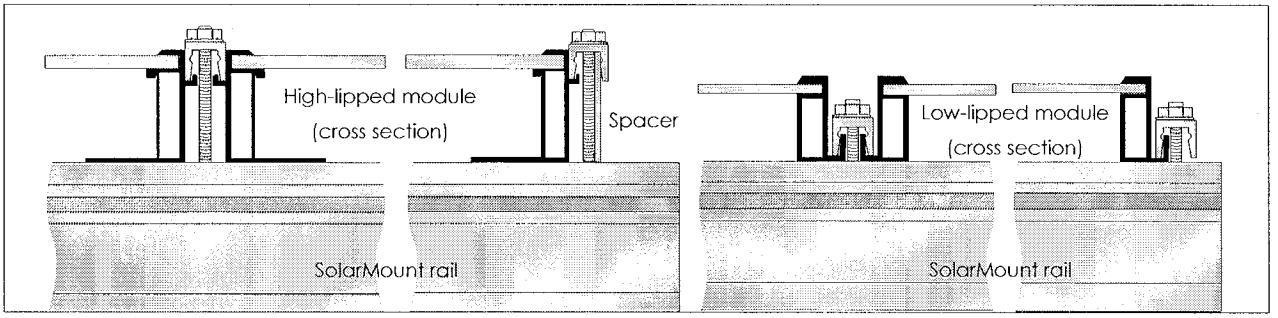


Figure 20. Mid clamps and end clamps for lipped-frame modules are identical. A spacer for the end clamps is necessary only if the lips are located high on the module frame.

[3.3] Installing SolarMount with bottom mounting clips

This section covers SolarMount rack assembly where the installer has elected to use bottom mounting clamps to secure modules to the rails. It details the procedure for flush mounting SolarMount systems to a pitched roof.

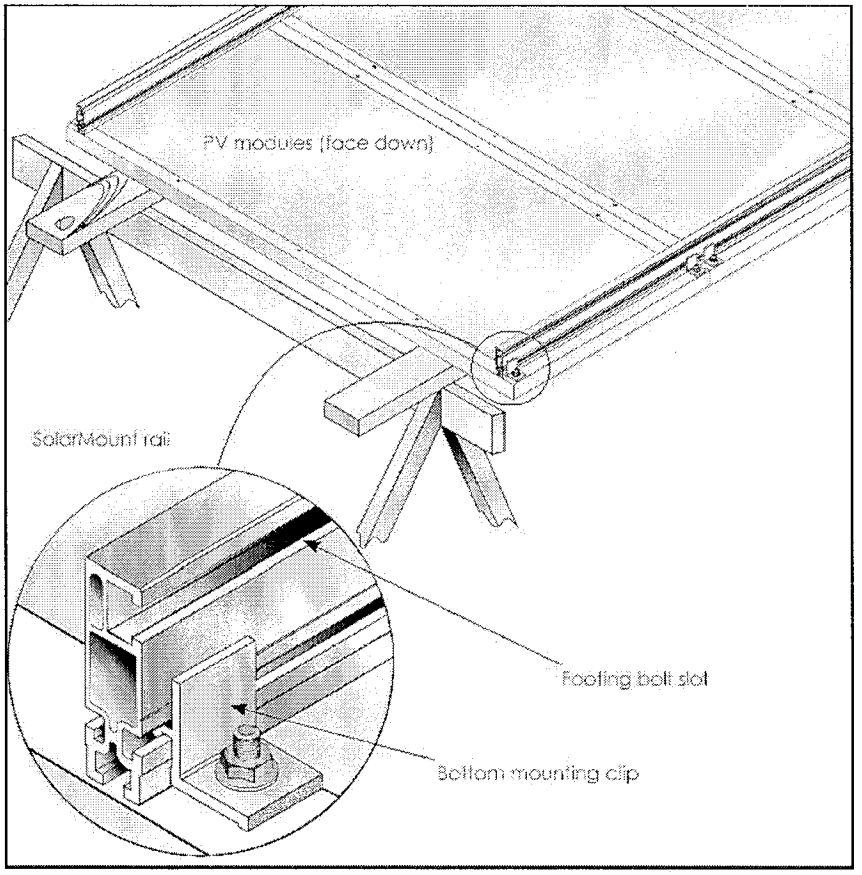


Figure 21. SMR and CB components

Table 16. Wrenches and torque

	Wrench size	*Recommended torque (ft-lbs)*
¼" hardware	7/16"	5
⅜" hardware	9/16"	20

Note: Torque specifications do not apply to lag bolt connections.

Stainless steel hardware can seize up, a process called galling. To significantly reduce its likelihood, (1) apply lubricant to bolts, preferably an anti-seize lubricant, available at auto parts stores, (2) shade hardware prior to installation, and (3) avoid spinning on nuts at high speed. See Installation Supplement 910, Galling and Its Prevention, at www.unirac.com.

[3.3.1] Planning the installation area

Decide on an arrangement for clips, rails, and L-feet (Fig. 22).

Use Arrangement A if the full width of the rails contacts the module. Otherwise use Arrangement B.

Caution: If you choose Arrangement B, either (1) use the upper mounting holes of the L-feet or (2) be certain that the L-feet and clip positions don't conflict.

If rails must be parallel to the rafters, it is unlikely that they can be spaced to match rafters. In that case, add structural supports – either sleepers over the roof or mounting blocks beneath it. These additional members must meet code; if in doubt, consult a professional engineer.

Never secure the footings to the roof decking alone. Such an arrangement will not meet code and leaves the installation and the roof itself vulnerable to severe damage from wind.

Leave enough room to safely move around the array during installation. The width of a rail-module assembly equals the length of one module. Note that L-feet may extend beyond the width of the assembly by as much as 2 inches on each side. The length of the assembly equals the total width of the modules.

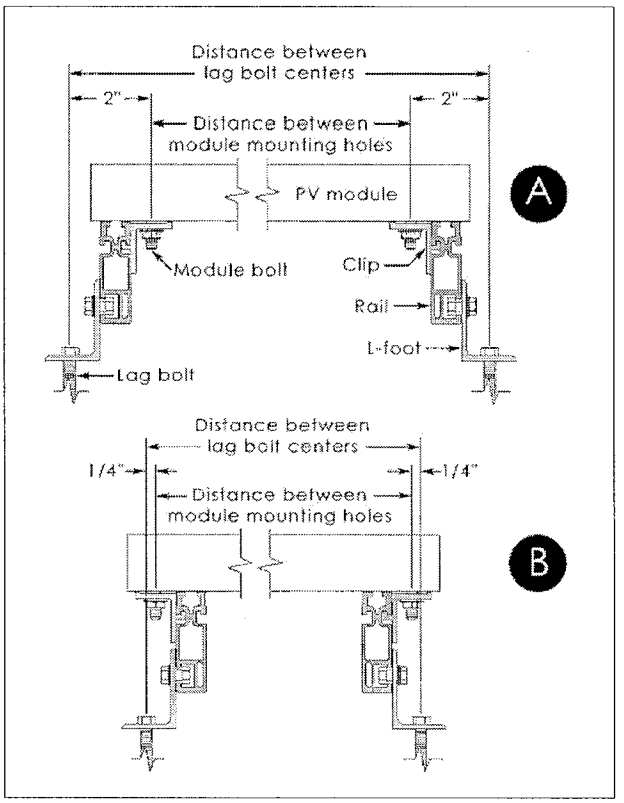


Figure 22. Clip Arrangements A and B

[3.3.2] Laying out the installing L-feet

L-feet are used for installation through existing low profile roofing material, such as asphalt shingles or sheet metal. They are also used for most ground mount installations. To ensure that the L-feet will be easily accessible during flush installation:

- Use the PV module mounting holes nearest the ends of the modules.
- Situate the rails so that footing bolt slots face outward.

The single slotted square side of the L-foot must always lie against the roof with the double-slotted side perpendicular to the roof.

Foot spacing (along the same rail) and rail overhang depend on design wind loads.

Install half the L-feet:

- If rails are perpendicular to rafters (Fig. 23), install the feet closest to the lower edge of the roof.
- If rails are parallel to rafters (Fig 24), install the feet for one of the rails, but not both.

For the L-feet being installed now, drill pilot holes through the roofing into the center of the rafter at each lag screw hole location.

Squirt sealant into the hole and onto the shafts of the lag screws. Seal the underside of the L-feet with a sealant. Securely fasten the L-feet to the building structure with the lag screws. Ensure that the L-feet face as shown in Figure 23 or Figure 24.

Hold the rest of the L-feet and fasteners aside until the panels are ready for the installation.

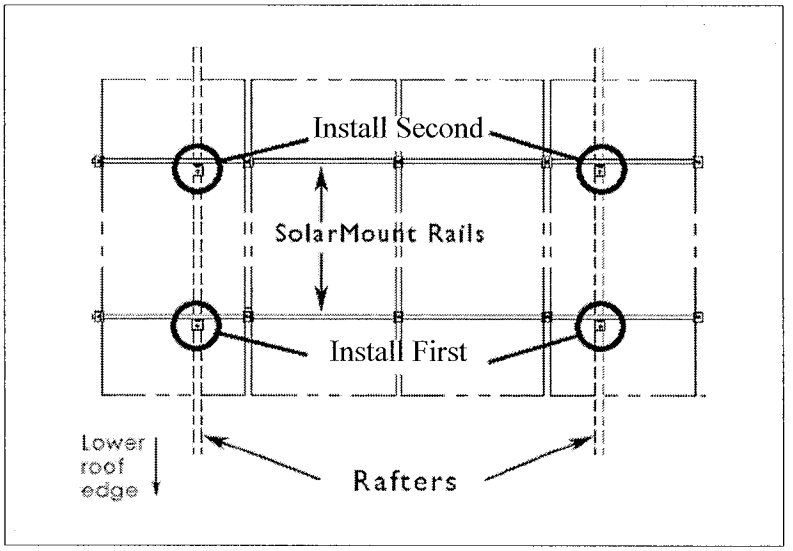


Figure 23. Layout with rails perpendicular to rafters.

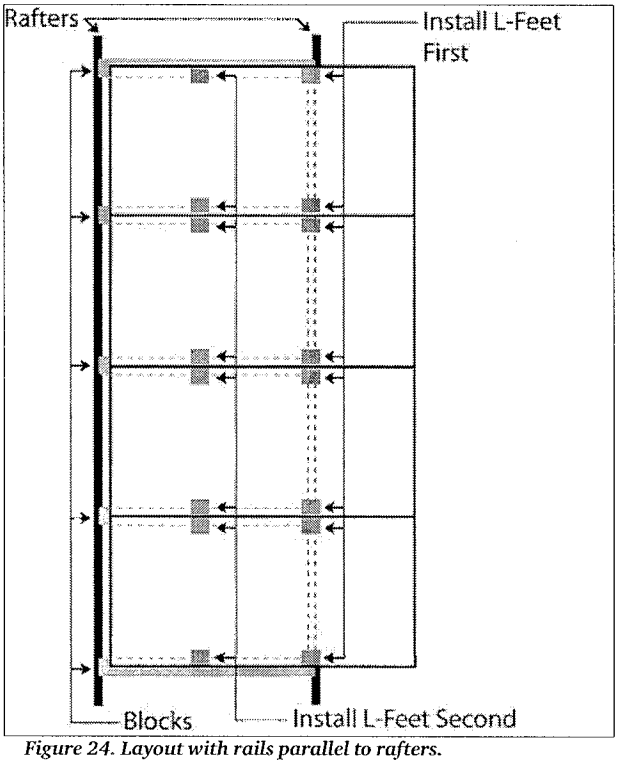


Figure 24. Layout with rails parallel to rafters.

[3.3.3] Attaching modules to the rails

Lay the modules for a given panel face down on a surface that will not damage the module glass. Align the edges of the modules and snug them together (Fig. 21, page22).

Trim the rails to the total width of the modules to be mounted. Place a rail adjacent to the outer mounting holes. Orient the footing bolt slot outward. Place a clip slot adjacent to the mounting holes, following the arrangement you selected earlier.

Assemble the clips, mounting bolts, and flange nuts. Torque the flange nuts to 5 foot-pounds.

Wire the modules as needed. For safety reasons, module wiring should not be performed on a roof. For a neat installation, fasten cable clamps to rails with self-tapping screws.

[3.3.4] Installing the module-rail assembly

Bring the module-rail assembly to the installation site. Keep rail slots free of debris that might cause bolts to bind in the slots.

Consider the weight of a fully assembled panel. Unirac recommends safety lines whenever lifting one to a roof.

Align the panel with the previously installed L-feet. Slide 3/8 inch L-foot mounting bolts onto the rail and align them with the L-feet mounting holes. Attach the panel to the L-feet and finger tighten the flange nuts.

Rails may be attached to either of two mounting holes in the footings (Fig. 25).

- Mount in the lower hole for a low, more aethetically pleasing installation.
- Or mount in the upper hole to maximize a cooling airflow under the modules. This may enhance performance in hotter climates.

Adjust the position of the panel as needed to fit the installation area. Slide the remaining L-feet bolts onto the other rail, attach L-feet, and finger tighten with flange nuts. Align L-feet with mounting holes previously drilled into the roof. Install lag bolts into remaining L-feet as described in "Laying out and installing L-feet" above.

Torque all footing flange nuts to 20 foot-pounds. Verify that all lag bolts are securely fastened.

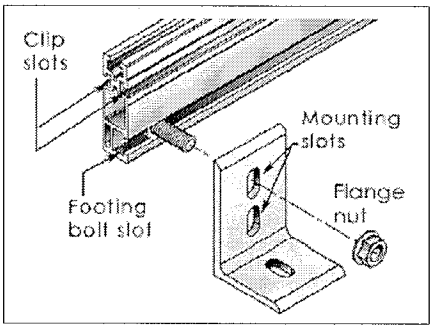
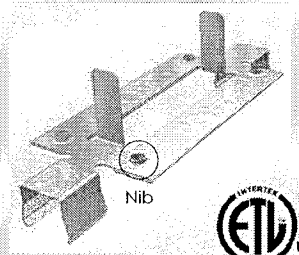


Figure 25. Leg-to-rail attachment

[3.4] Installing SolarMount with grounding clips and lugs

Clips and lugs are sold separately

UGC-1



Conforms to UL Standard 467

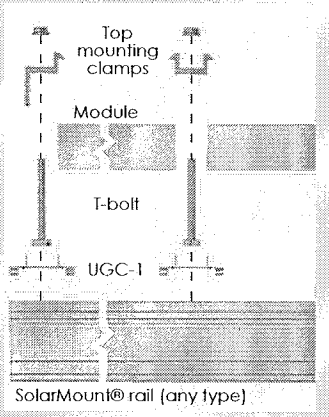
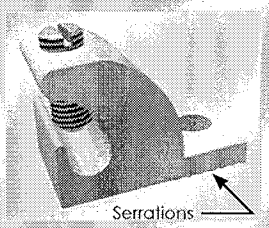


Figure 26. Slide UGC-1 grounding clip into top mounting slot of rail. Torque modules in place on top of clip. Nibs will penetrate rail anodization and create grounding path through rail (see Fig. 3, reverse side).

UGL



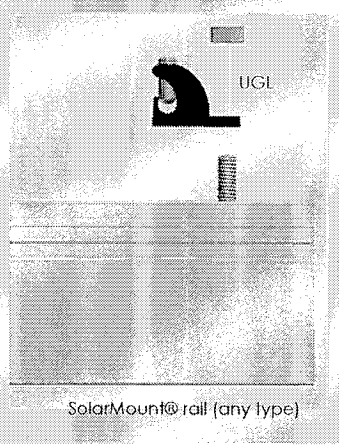
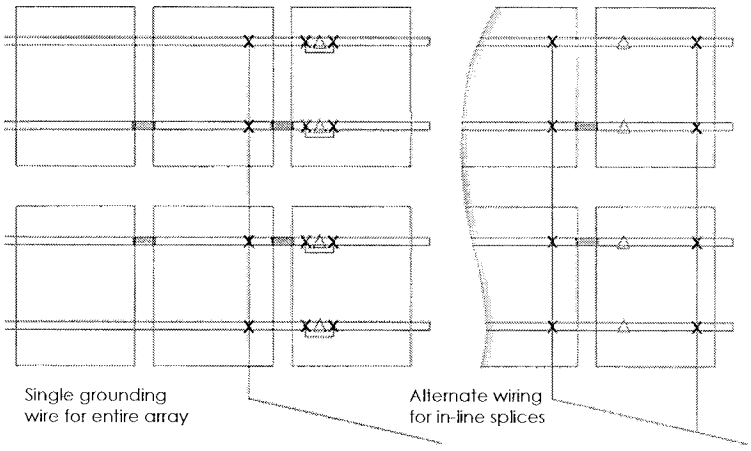


Figure 27. Slide ¼-inch hex bolt into top mounting slot of any SolarMount® rail (standard, HD, or light). Secure nut with 7/16-inch crescent wrench with sufficient torque for lug serrations to penetrate anodized surface of rail.

Figure 28. Place grounding clips, lugs, and copper wire (6–10 AWG). Place a loop in the wire around splices to prevent tension. Be sure wiring between rails is not taut.

KEY

- PV module
- SolarMount rail (any type)
- △ Rail splice
- X Grounding lug
- Grounding clip
- Copper wire



10 year limited Product Warranty, 5 year limited Finish 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, except for the anodized finish, which finish shall be free from visible peeling, or cracking or chalking under normal atmospheric conditions for a period of five (5) 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 ("Finish Warranty").

The Finish Warranty does not apply to any foreign residue deposited on the finish. All installations in corrosive atmospheric conditions are excluded. The Finish Warranty is VOID if the practices specified by AAMA 609 & 610-02 – "Cleaning and Maintenance for Architecturally Finished Aluminum" (www.aamanet.org) are not followed by Purchaser. 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, 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 periods 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.

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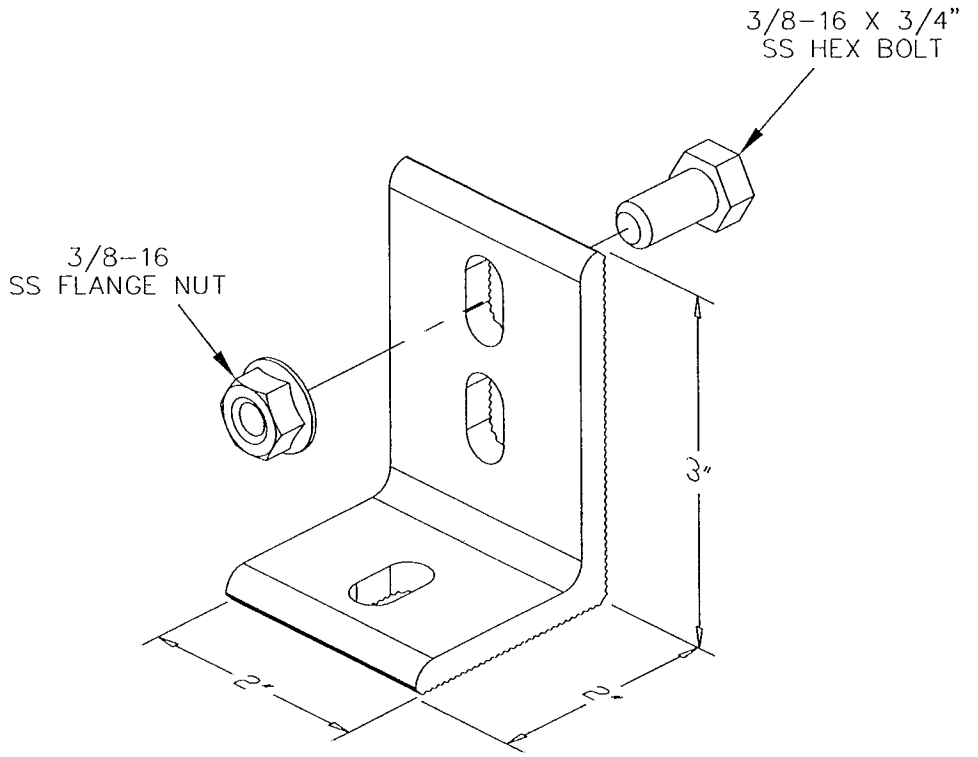
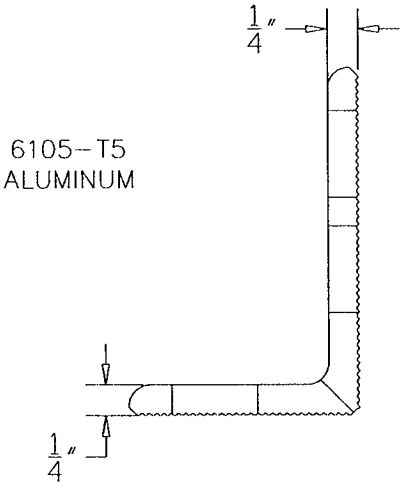
UNIRAC L FOOT AND MOUNTING DETAIL
PART# 310068





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UNIRAC-310068

SolarMount/SunFrame

2" Aluminum Serrated L-Foot

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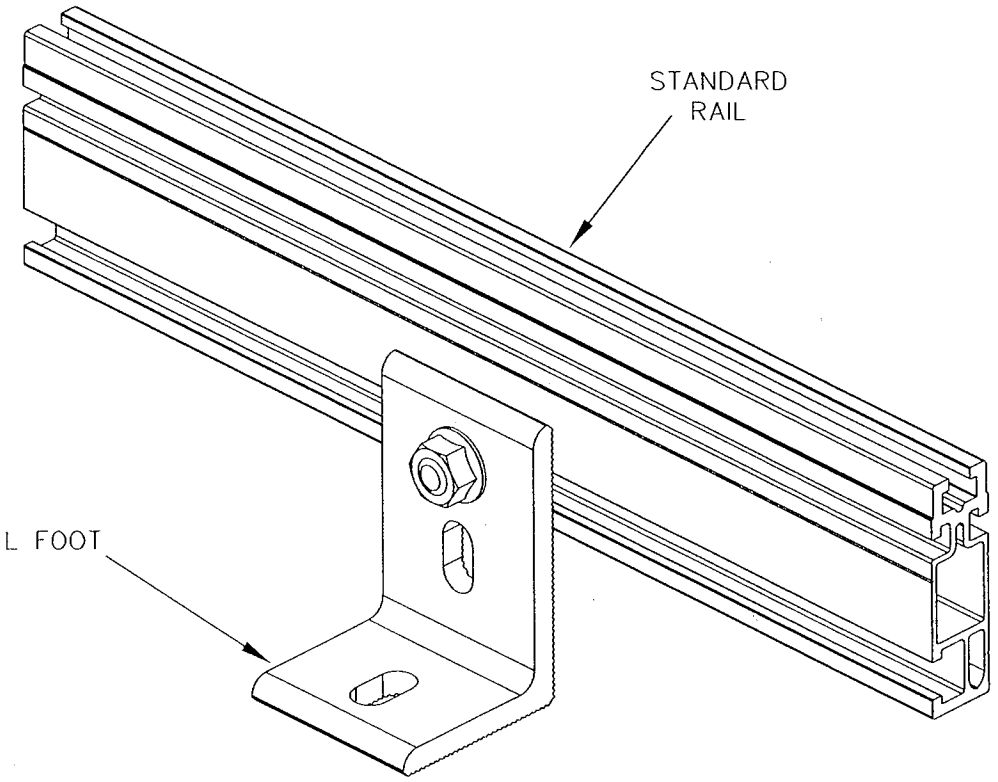

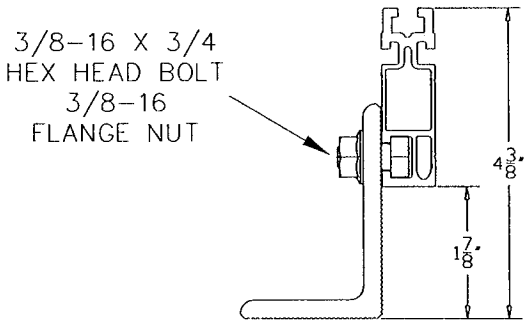

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URASSY-0002

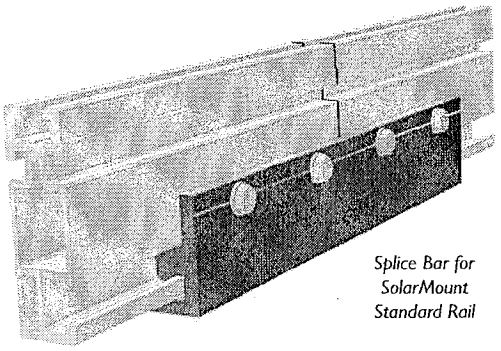
Installation Detail

SolarMount Rail
L-Foot Connection

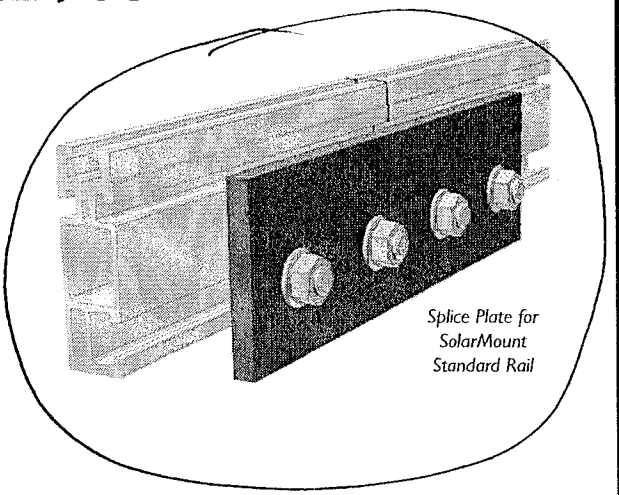
UNIRAC

UNIRAC RAIL SPLICE
PART# 310214

Splices/Expansion Joints Installation Manual 908.1



Splice Bar for SolarMount Standard Rail



Splice Plate for SolarMount Standard Rail

[1] Installer responsibility

The installer is solely responsible for:

- Complying with all applicable local or national building codes, including any that may supercede 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 building live load conditions;
- Using only UniRac parts and installer-supplied parts as specified by UniRac (substitution of parts may void the warranty);
- Maintaining the waterproof integrity of the roof; and
- Ensuring safe installation of all electrical aspects of the PV array.

[2] Applications

Splice bars are structural elements that may be used to join together lengths of one of the extruded aluminum rails used in UniRac products: SolarMount™ standard, SolarMount™ Light SolarMount™ HD (heavy duty), or SunFrame™.

Splice plates are also structural and may be used only with the two types of SolarMount rail.

Although structural, neither type creates a joint that is as strong as the rail itself. A rail should always be supported by ***more than one*** footing on ***both*** sides of the splice. (Manuals for code compliant planning and installation for SolarMount and SunFrame can be downloaded at the respective product pages at www.unirac.com.)

Because of these support requirements, ***never*** use either type of splice in conjuction with the following applications:

- PV PoleTops™
- PV PoleSides™
- SolarMount arrays with high profile tilt legs
- U-LA large arrays

UniRac Installation Manual

Pub 071105-1ii
November 2007

UNIRAC® THE STANDARD IN PV MOUNTING STRUCTURES™

*See **www.unirac.com** for your nearest UniRac distributor.*

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In runs exceeding 45 feet of rail, UniRac recommends the use of expansion joints. Runs of rail less than 45 feet in length, with more than two pairs spliced together, are an acceptable installation for the SolarMount and SunFrame systems. As long as installations conform to the standard methods outlined in the Installation Manual 214 (SolarMount) and 808.1 (SunFrame), it will not void the UniRac warranty.

Expansion joints

Expansion joints prevent buckling of rails due to thermal expansion. In runs of rail exceeding 45 feet, expansion joints are required. Only the splice bars, not splice plates, may be used for thermal expansion joints.

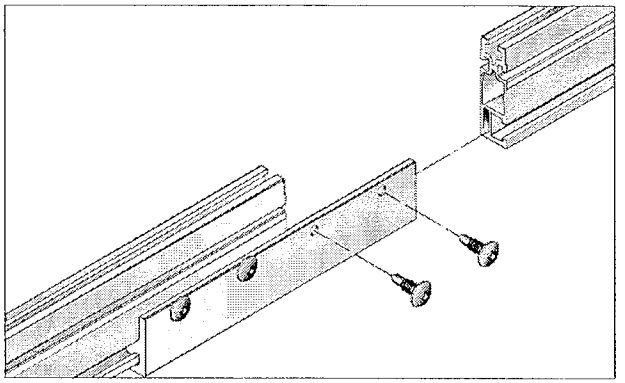
To create a thermal expansion joint, slide the splice bar into the footing slots of both rail lengths. Leave approximately half an inch between the segments. Secure the splice bar with two screws on one side only. Footings (such as L-feet or standoffs) should be secured normally on both sides of the splice.

No PV module or mounting hardware component should straddle the expansion joint. A string of modules must clearly end before the joint with mounting hardware (top mount clamps, of bottom up clips) terminating on that rail. The next string of modules would then commence following the splice with mounting hardware beginning on the next rail.

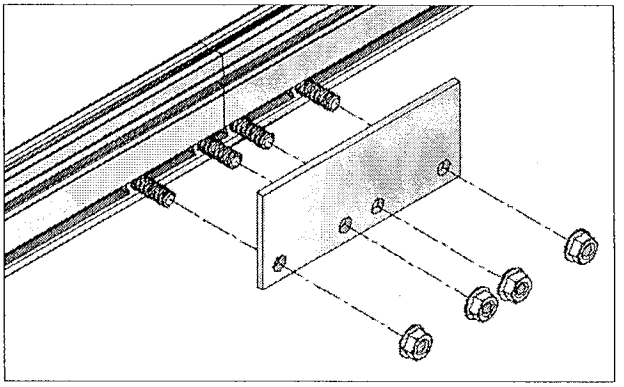
Exceptions may be allowable – contact UniRac.

Caution

Stainless steel hardware can seize up, a process called galling. To significantly reduce the likelihood of galling, apply a small drop of anti-seize lubricant to the threads of all bolts before installation. Anti-seize lubricants are readily available in any auto parts and some hardware stores. In their absence, any lubricant will reduce chances of galling.



Splice bars slide into the footing bolt slots of SolarMount or SunFrame footing bolt slots. They are secured by No. 10 x 5/8-inch pan head screws. Expansion joints are secured on one side only.



Splice plates are for use with SolarMount standard and HD rails only. Hexhead bolts slide into the footing slots of the rails. Flange nuts secure the plate.

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. 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, 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 the 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.

1411 Broadway NE, Albuquerque NM 87102-1545 USA • 505.242.6411 • Fax 505.242.6412

STRUCTURAL REVIEW & PERMITTING

PLAN EXAMINATION LETTER

PROJECT #: **209176026**

Neighborhood Preservation & Inspection Division
215 Martin Luther King, Jr. Blvd
Madison, Wisconsin 53703
608 266-4551 **Fax** 608 266-6522

Date: June 25, 2009

PATRICK FARRELL
H & H SOLAR
PO BOX 44267
MADISON WI 53744

Occupancy: Storage Group S1
Tenant: rooftop solar panels
Owner: City of Madison Water Utility
Supervising Professional: Patrick Farrell

Project Location
1408 QUANN-OLIN PARKWAY

These plans have been reviewed for compliance with the important code requirements in Chapters COMM 61 through 66 of the Wisconsin Administrative Code.

The **ROOFTOP SOLAR INSTALLATION** plans are **CONDITIONALLY APPROVED.**

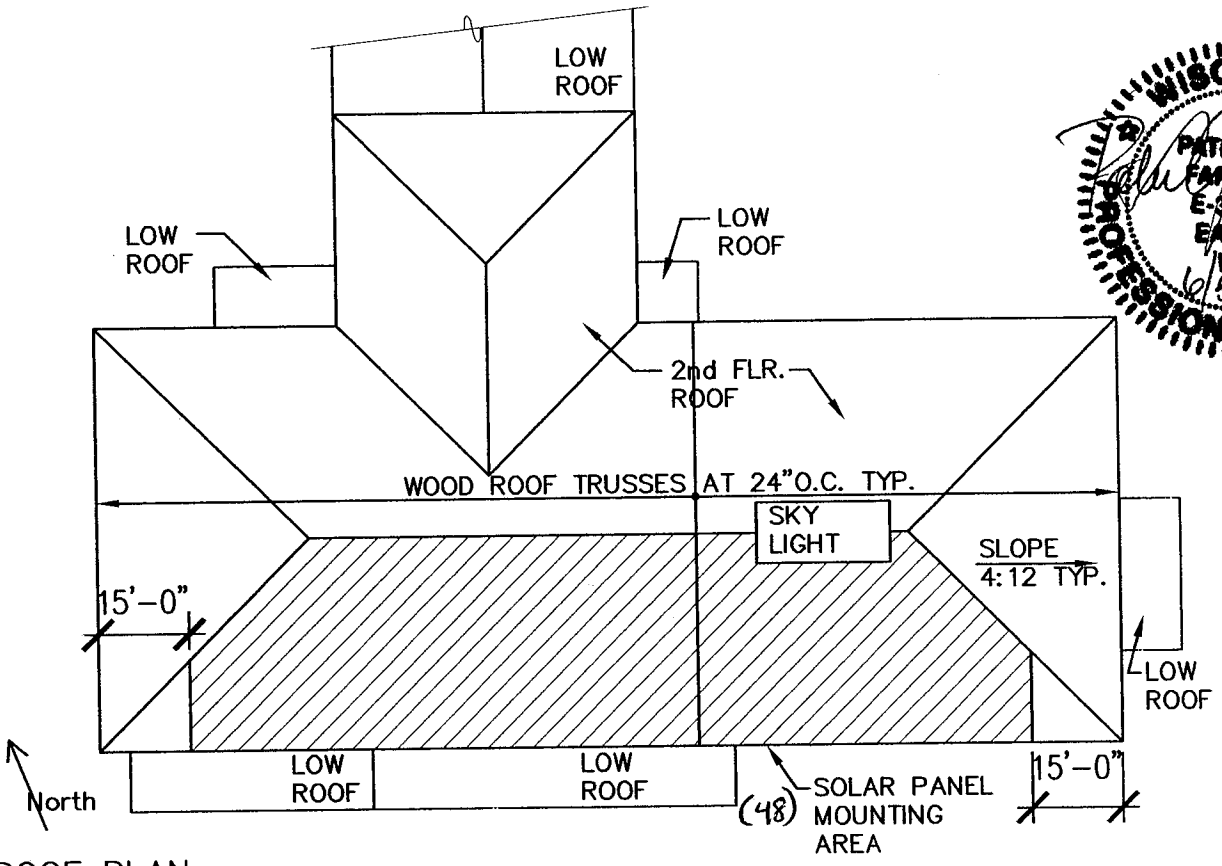
The plans have been reviewed for compliance with the code requirements set forth in Chapters COMM 61-66 of the rules of the Department of Commerce. Construction may proceed subject to local regulations, but all items that are required to be changed by this letter must be corrected before commencing that part of the work. This plan has not been reviewed for compliance with Chapters COMM 82-86, the plumbing rules of the Department of Commerce. You are hereby advised that the owner as defined in Chapter 101.01(2)(e) of Wisconsin State Statutes is responsible for all code requirements not specifically cited herein. The building will be inspected during and after construction.

COMM 61.33 Evidence of Approval. The architect, professional engineer, designer, builder or owner shall keep, at the building, one set of plans bearing the stamp of approval.

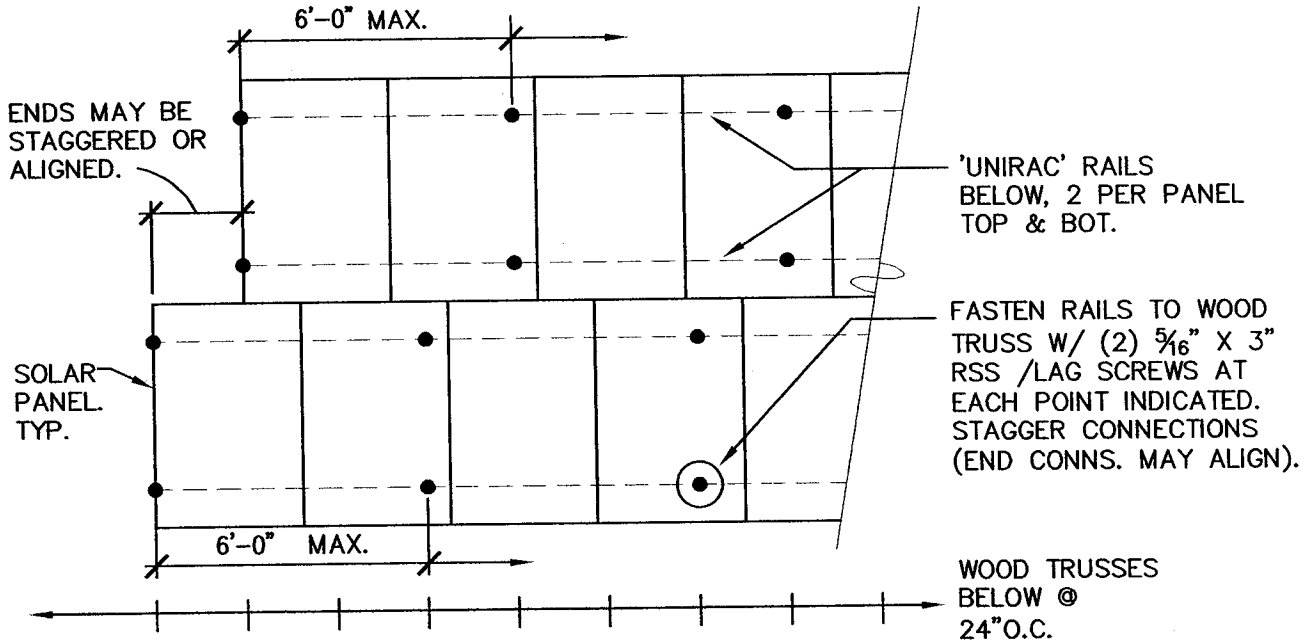
THIS BUILDING HAS BEEN CLASSIFIED AS TYPE **IIB** CONSTRUCTION.

Inspector(s): **George Stulgaitis** Phone: 266-5910

Reviewed By: **Alan Harper, Plan Examiner** Phone: **266-4558** Supervisor: **Harry Sulzer**



ROOF PLAN
N.T.S.



TYPICAL PANEL CONNECTION LAYOUT
1/4" = 1'-0"

Castle Engineering Solutions, LLC 3215 Golf Road, #210 Delafield, WI 53018 Phone 262/613-8656	MADISON WATER UTILITY Administrative / Office Building 6/05/09 JOB# 60908	S1 Sheet No.

CASTLE
ENGINEERING SOLUTIONS LLC
3215 GOLF ROAD, #210
DELAFIELD, WI 53018
(262) 613-8656

ANALYSIS OF EXISTING STRUCTURES:

1. MAIN OFFICE/ADMIN BUILDING

BASIS OF ANALYSIS: 1. SITE VISIT MAY 28, 2009
2. BRAY ASSOC. DRAWINGS DATED 3.16.04
3. WISCONSIN COMMERCIAL BLDG. CODE
4. IBC 2006 / ASCE 7-05

A. Design loads (RE: BRAY DWG. SO-01):

I. SNOW LOAD

P_f = 25 psf Flat Roof
P_g = 30 psf Ground

$C_e = 1.0$ $I = 1.0$ $C_t = 1.1$

Unbalanced Snow Loads: (Upper Roof) 45 psf leeward, 10 psf windward

II. Wind: V = 90 mph $I_w = 1.0$ Exposure B 20 PSF MWFRS
C&C vary based on size & location

III. Seismic Design: Use Group I $SDS = 0.188\,G$
Site Class E Conc Shear Walls $SD1 = .105\,G$

IV. Dead loads: Wood Trusses 10 PSF Top Chord
+5 PSF in overframe areas 10 PSF Bottom Chord
Per Bray Assoc./Graef Anhalt Schloemer design SO-01

B. ACTUAL LOADS

I. SNOW

Snow load required by Code (IBC '06/ASCE 7-05):

P_f = 20.8 PSF (see attached calc)
P_s = 20.3 PSF (" ")

Unbalanced load: 6.2 psf windward (see attached calc)
20.8 psf leeward (" ")
+20.9 psf surcharge for 9.36 feet from ridge
41.7 psf max.

II. ⇒ 4.2 PSF ADDITIONAL UNIFORM LOAD CAPACITY ABOVE CODE MINIMUM, AND 3.3 PSF UNBALANCED SNOW LOAD

WEIGHT OF KYOCERA SOLAR PV PANELS = $\frac{40.8\#}{(\frac{69}{12})(\frac{39}{12})} = 2.5\,PSF$

ADDITIONAL SNOW LOAD CAPACITY > PANEL WEIGHT

Castle Engineering Solutions LLC
ASCE 7-05
Snow Load Calculations

Date: 6/1/2009
Project: Madison Water Utility
Location: Madison, WI
Client: H&H Solar Energy Services

Flat Roof Snow Load:

$p_f = 0.7 * C_e * C_t * I * p_g$ (Equation 7-1)

p_g =	30	psf	Figure 7-1 (Ground snow load) Madison, WI
I =	1.0		Table 7-4 (Importance factor) Non-hazardous/essential/agricultural
C_t =	1.1		Table 7-3 (Thermal factor) Vent space >25F different than heated space
C_e =	0.9		Table 7-2 (Exposure factor) Terrain category B, fully exposed
p_f =	20.8	psf	

Sloped Roof Snow:

$p_s = C_s * p_f$

C_s =	1.0		Figure 7-2b
p_s =	20.8	psf	

Castle Engineering Solutions LLC

ASCE 7-05

Snow Load Calculations

Date: 6/1/2009
Project: Madison Water Utility
Location: Madison, WI
Client: H&H Solar Energy Services

Reference: Figure 7-9

Input data:

p_g =	30.0	psf	Figure 7-1, ground snowload
p_s / p_f =	20.8	psf	See previous calc sheet
l_u =	34.7	feet	windward building width

Density of snow, (gamma):

(gamma) = 0.13 p_g + 14

(gamma) = 17.9 pcf

Balanced snow height, h_b:

h_b = p_f/(gamma) or p_s/(gamma)

h_b = 1.2 feet

Drift height, h_d:

h_d = 0.43 (l_u)^(1/3) (p_g + 10)^(1/4) - 1.5

h_d = 2.0 feet

Drift width, W:

W = 4 h_d

W = 8.10 feet

Castle Engineering Solutions LLC

ASCE 7-05

Snow Load Calculations

Date: 6/1/2009
Project: Madison Water Utility
Location: Madison, WI
Client: H&H Solar Energy Services

Reference: Section 7.6

Input data:

Roof pitch	4	in 12	S =	3.00	run per 1 unit rise
h_d =	2.0	feet	See previous calc sheets		
(gamma) =	17.9	pcf	See previous calc sheets		
p_s =	20.8	psf	See previous calc sheets		

Windward: p_{wind} = **0.3 ps** = 6.2 psf

Leeward: p_{lee} = **ps** = 20.8 psf

Leeward surcharge load, p_{sur}:

$p_{sur} = h_d * (gamma) / S^{(1/2)}$

p_{sur} = 20.9 psf

Surcharge length, b_{sur}:

$b_{sur} = 8\ S^{(1/2)} * h_d / 3$

b_{sur} = 9.36 feet