



# Installation Manual for PVL on Membrane: a Building Integrated Photovoltaic Flat Roof Solution using TPO and EPDM Membrane Roofing Systems

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For Top Terminated Laminates: PVL-31, PVL-62, PVL-68T, PVL-124T, PVL-128T, PVL-136T and PVL-144T supplied with "Quick Connect" Terminals

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*Installation Manual for Building-Integrated Photovoltaic Flat Roof  
Solution using TPO and EPDM Membrane Roofing Systems  
PVL-31, PVL-62, PVL-68T, PVL-124T, PVL-128T, PVL-136T  
and PVL-144T*

## SECTION #1

### 1.1 Introduction

United Solar Ovonic, LLC (“UNI-SOLAR®”), the leader in thin-film amorphous-silicon photovoltaics (PV) offers a revolutionary new line of building integrated photovoltaic flat roof solutions using TPO and EPDM membrane roofing systems. Unlike other photovoltaic solutions that use glass modules mounted on racks, UNI-SOLAR® flat roof solutions are lightweight and architecturally attractive. These rooftop solar systems, where UNI-SOLAR® PVL modules are bonded on new TPO and EPDM (minimum 60 mil) roof membranes, emulate conventional flat roof solutions in design, construction, function and installation.

UNI-SOLAR® photovoltaic laminates (PVL) are designed to provide many years of reliable roofing protection and independent electric power. They will perform at their maximum with the proper power system design, installation, use and maintenance. This manual is designed to assist product owners, roofers, and electricians in the proper use and installation of this product.

The UNI-SOLAR PVL Series modules are lightweight and flexible. The laminates come with the bonding adhesive factory installed on the back of the laminate. The back of the laminate is fully covered with a “peel and stick” adhesive. The laminates are also supplied with Quick Connect terminals for easy wiring. Installation of the membrane (with laminates) requires only a few, but important, modifications of the conventional installation procedures. Roofers should be thoroughly familiar with the standard procedures prior to installation. Only qualified, licensed electricians should undertake wiring of the panels to the building’s electrical system.


UNI-SOLAR PV laminates are designed for use with other specialized equipment, including DC combiner boxes, charge controllers, DC/AC inverters, and ground fault protection and interruption equipment. System design and component selections must comply with the National Electric Code (NEC) and all state and local codes.

### **DISCLAIMER OF LIABILITY**

The information contained in this manual is based on United Solar Ovonic, LLC knowledge and experience, but such information and suggestions do not constitute a warranty expressed or implied. The methods of installation, use and maintenance of membrane roofing materials are beyond the control of United Solar Ovonic, LLC. United Solar Ovonic, LLC assumes no responsibility and expressly disclaims liability for any loss, damage or expense associated with the use, installation or operation of the membrane roofing system. Any liability of United Solar Ovonic, LLC is strictly limited to the Limited Warranty. United Solar Ovonic, LLC reserves the right to make changes to product specifications or to this manual without notice.

## 1.2 Safety Warnings

- The *UNI-SOLAR* Field Applied PV laminates produce DC electricity when exposed to the sun or other light sources. The power from one individual panel is not considered hazardous. However, if connected in series and/or connected in parallel, the potential shock hazard increases.
- Do not attempt to concentrate sunlight on the laminates for increased output. Doing so may cause damage and will void the warranty.

**CAUTION!!** 

**The *UNI-SOLAR* PV laminates contain live electrical components enclosed and protected within. Do not cut or trim the photovoltaic laminate (bonded to the membrane roofing material) in any way. Do not drive screws into any part of the photovoltaic laminate. Doing so can cause electric shock, may result in fire and will void the warranty.**

### ***Roofing Contractors and Licensed Electrician' Responsibilities:***

- Only licensed roofers should install *UNI-SOLAR* PV membrane roofing products.
- *UNI-SOLAR* PV membrane roofing products are slippery, especially when wet. Use extreme caution and proper safety gear when working on or near the panels.
- Do not place equipment on PV laminates.
- Contact appropriate local authorities prior to installation to determine if permits and inspections are required for your particular area.
- Installation shall be in accordance with CSA 22.1, Safety Standard for Electrical Installations, Canadian Electrical Code, Part 1.
- Observe safe electrical practices at all times. Use insulated tools when wiring solar PV laminates.
- Cover solar panels with an opaque material before making wiring connections to reduce the risk of electric shock or sparks.
- Observe proper polarity when connecting the solar PV laminates into an electrical circuit (see section on wiring). Reverse connection will damage the PV laminates, may result in fire and will void the warranty.
- Avoid dropping any sharp objects on solar PV laminates.

### 1.3 General TPO and EPDM Membrane Installation Notes

- Locate area within the roof system that provides adequate drainage and does not pond water.
- Do not install in areas where shadows are caused by nearby permanent, roof-mounted building equipment or walls.
- Location should receive maximum allowable sunlight.
- Location should be limited to the interior of roof so as not to place the PV laminates in areas where wind uplift is at its maximum (ex. corners of the roof space or along the edges of the roof space).
- The *UNI-SOLAR* PVL laminates are bonded to the membrane roofing material following procedures detailed in this manual.
- Weather tightness is a function of the membrane roofing installer.
- Metal wire covers shall not be attached unless the proper sealant is placed under or around the wire cover assemblies. Sealant shall be field applied on dry clean surfaces.
- Some field cutting and fitting of membrane material and flashing is to be expected by the installer and minor field corrections are a part of normal installation work.
- **NOTE: The PV laminates cannot be cut or penetrated in any way!**
- Roofing slope to be 5/8:12 (3°) or greater.
- Additional help can be found in the membrane roofing material supplier's installation instructions.

#### ***Approved Substrates and Suppliers:***

##### **TPO Substrates:**

GenFlex White TPO, GenFlex Gray TPO, GenFlex Charcoal Grey TPO, 60 mil.

##### **TPO Vendors:**

Firestone (GenFlex)

##### **EPDM Substrates:**

GenFlex EPDM, GenFlex FRM II, GenFlex AFR, GenFlex II FR EPDM and GenFlex FRM-FR II, Firestone Building Products: Standard RubberGard, Standard Reinforced RubberGard, FR RubberGard, Fire Retardant Reinforced RubberGard or LS FR, 60 mil.

UNI-SOLAR®

**EPDM Vendors:**

Firestone (GenFlex) (EPDM meets ASTM 4637 Type 1, Grade 1, Class U)

## 1.4 UNI-SOLAR PV Laminate (PVL) Specifications

### Physical Specifications:

Product	Laminate Length	Laminate Width	Laminate Thickness	Weight
PVL-31	4 ft. 7 ½ in.	15½ in.	0.12 in.	4.1 lb.
PVL-62	8 ft. 6 ¾ in.	15½ in.	0.12 in.	8.2 lb.
PVL-68	9 ft. 4⅞ in.	15½ in.	0.12 in.	9 lb.
PVL-124	16 ft. 5¼ in.	15½ in.	0.12 in.	16.5 lb.
PVL-128	18 ft.	15½ in.	0.12 in.	17 lb.
PVL-136	18 ft.	15½ in.	0.12 in.	17 lb.
PVL-144	18 ft.	15½ in.	0.12 in.	17 lb.

### Electrical Specifications:

Product	PVL-31	PVL-62	PVL-68	PVL-124	PVL-128	PVL-136	PVL-144
Rated Power (Watts) $P_{max}$	31	62	68	124	128	136	144
Nominal Operating Voltage	12	12	12	24	24	24	24
Operating Voltage (Volts) $V_{mp}$	7.5	15.0	16.5	30.0	33.0	33.0	33.0
Operating Current (Amps) $I_{mp}$	4.13	4.13	4.13	4.13	3.88	4.13	4.36
Open-Circuit Voltage (Volts) $V_{oc}$	10.5	21.0	23.1	42.0	47.6	46.2	46.2
Short-Circuit Current (Amps) $I_{sc}$	5.1	5.1	5.1	5.1	4.8	5.1	5.3
Series Fuse Rating (Amps)	8	8	8	8	8	8	8
Min. Blocking Diode	8	8	8	8	8	8	8

## NOTES:

- During the first 8-10 weeks of operation, electrical output exceeds specified ratings. Power output may be higher by 15%, operating voltage may be higher by 11% and operating current may be higher by 4%.
- Electrical specifications tolerance for  $P_{max}$  is +/-5% and for other parameters is +/-10%. Electrical specifications are based on measurements performed at standard test conditions of 1000 W/m<sup>2</sup> irradiance, Air Mass 1.5, and cell temperature of 25°C (per ASTM E892) after long-term stabilization. Actual performance may vary up to 10% from rated power due to low temperature operation, spectral and other related effects.
- Under normal conditions a photovoltaic module may experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of  $I_{SC}$  and  $V_{OC}$  marked on UL Listed modules should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fuse sizes and size of controls connected to the module output. Refer to Section 690-8 of the National Electric Code for an additional multiplying factor of 1.25 which may be applicable.
- Maximum system open-circuit voltage not to exceed 600 VDC.
- Specifications subject to change without notice.

\* PVL-68 and PVL-136 laminates rated at 64 watts and 128 watts respectively are produced in limited quantities. Please contact your distributor for availability.

## Roof Specification

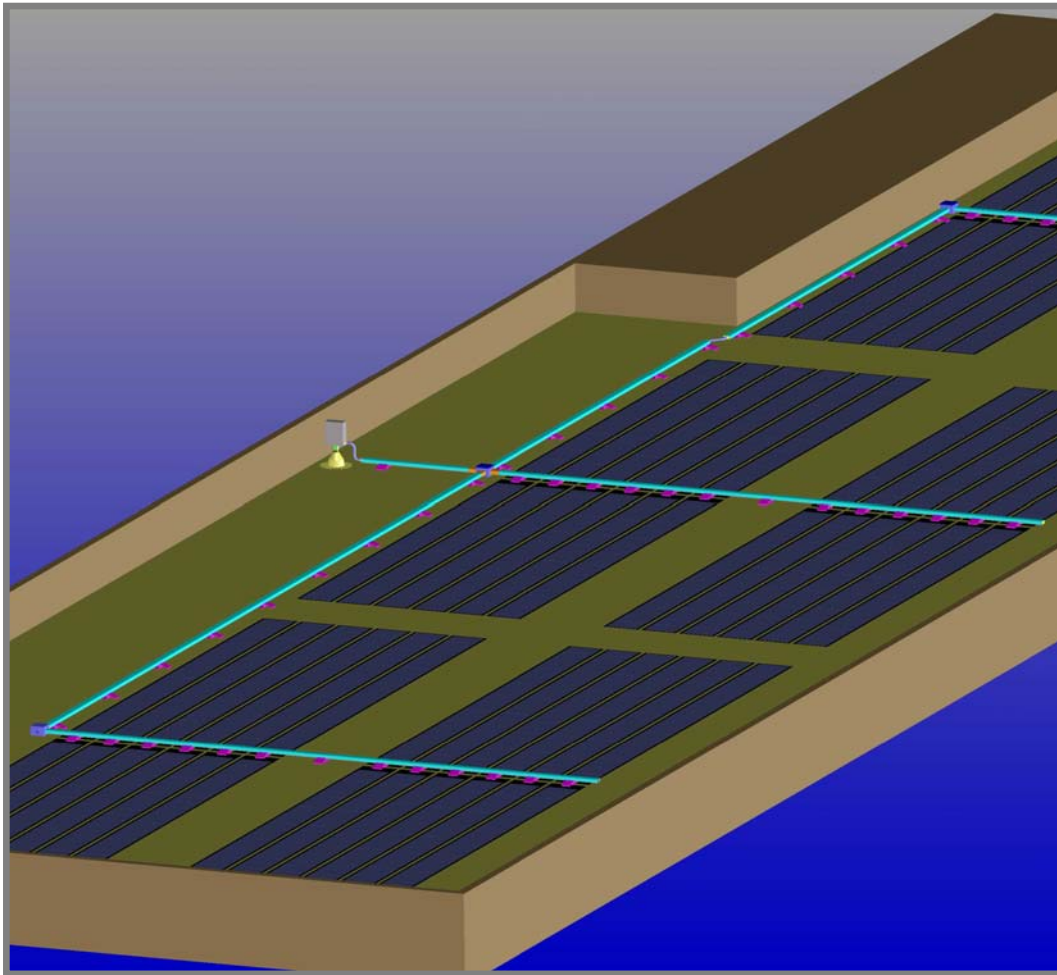
The PVL module can only be installed on sloped, approved substrates of roofing systems where the roof slope is between 3° degrees and 60° degrees (see 'Approved Substrates and Suppliers' of this manual). In all cases, the *UNI-SOLAR* PV laminates cannot be applied to roofs that will experience temperatures in excess of 85°C (185°F).

In all cases, the bonding of laminates in the field must be accomplished when the laminates and ambient temperatures are between 10°C (50°F) and 38°C (100°F). If the laminates are too cold, the adhesive will not cure as quickly. If the laminates are too hot, the removable film over the adhesive will become difficult to remove as you are bonding the laminate to the membrane material.

## PVL Models and Part Numbers:

Description	Model	Part Number
32 W, Top termination, potted terminal housing with Quick Connects	PVL-32T-QC	M532128
62 W, Top termination, potted terminal housing with Quick Connects	PVL-62T-QC	M534128
68 W, Top termination, potted terminal housing with Quick Connects	PVL-68T-QC	M535128
124 W, Top termination, potted terminal housing with Quick Connects	PVL-124T-QC	M537128
128 W, Top termination, potted terminal housing with Quick Connects	PVL-128T-QC	M438128
136 W, Top termination, potted terminal housing with Quick Connects	PVL-136T-QC	M538128
144 W, Top termination, potted terminal housing with Quick Connects	PVL-144T-J	M638128





General System View of Laminates  
on the Roof of a Building

## 1.5 Application of PV Laminates to the Membrane

### *Transportation and Handling of PVL Products*

- *UNI-SOLAR* field applied PV laminates are shipped coiled in a 4'x4'x17" transport boxes.
- *UNI-SOLAR* field applied PV laminates are to be stored in a ambient temperatures of 15°C to 30°C (50°F to 85°F)
- *UNI-SOLAR* PV laminates must be handled so as to not crease or bend the solar cells. Cells are interconnected with copper bus bars and these bus bars must not be stretched beyond their tolerances by coiling the laminate any tighter than **20 inches** in diameter.

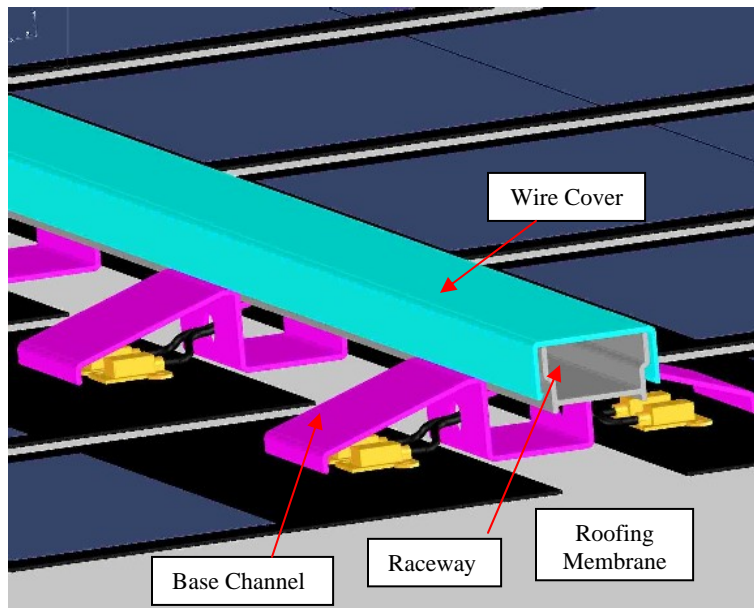
- Avoid standing on the PV laminates whenever possible. If unavoidable, wear clean, soft-soled shoes and walk in the center of the panel. **CAUTION!!** Laminates are very slippery when wet.

### **Supplied Equipment and Required Tools**

- All boxes of PV Laminates that are manufactured with the “quick connect” terminations contain the PV laminates, cable strain relief (two cable mounts and two cable ties per laminate) and a template for indicating proper screw penetration areas (see View 15).
- All shipments of PVL product can be accompanied by a factory supplied lamination roller (Contact *UNI-SOLAR* Sales office). This roller is called a J-roller because of its shape. Other rollers can be used but we recommend that the roller itself be made of a soft rubber material, ergonomically shaped for effective pressing and the handle of the roller attached to only one side of the roller axle.

### **Description of Parts:**

- PV modules with Top terminal housings with Quick Connects and “peel and stick” adhesive to adhere to approved substrates
- GenFlex Clear Primer (3 Gal. Containers), Medium nap roller and cotton rags
- Extruded PVC wire duct and cover, end caps and cover expansion profile
- Extruded CPVC base channels to protect the wire terminals
- Metallic Junction Boxes and Flexible Conduit



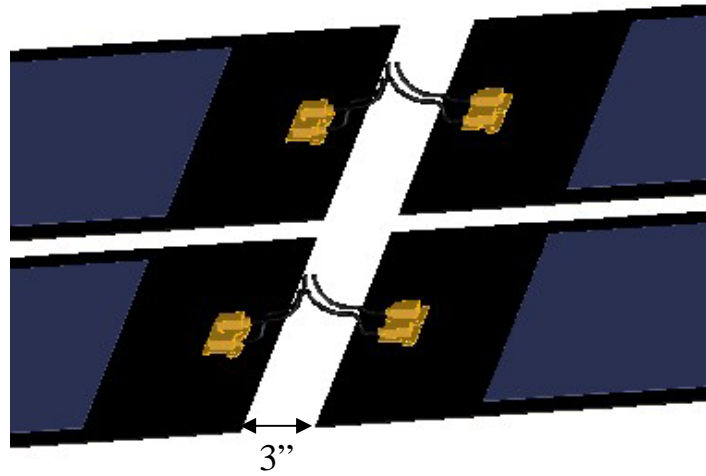
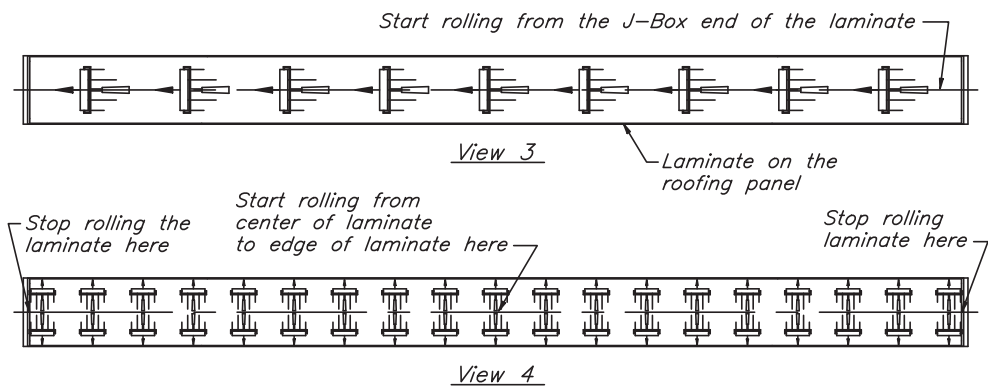
***PV Laminate Application Method:***

The PV laminates will be adhered to the roofing membrane using a peel and stick adhesive.

1. Clean the membrane roofing material, per the membrane manufacturer's current Technical Specifications for the membrane type (TPO or EPDM), where the laminate (with adhesive) will be placed.
2. Determine the overall size of the PV Laminate array and plan where the array will be located on the roof.
3. Allow the roof to dry completely so as not to trap any moisture between the roofing membrane and the laminate.
4. Prime the roof in the area where the PV laminates will be bonded to the roof with GenFlex Clear Primer. The procedure for this operation is detailed in the Technical Specifications for membrane type (TPO or EPDM).

**Note: Cleaning and application of the primer should be done on a larger area than the area covered by the PV Laminates to ensure that all of the PV Laminates are installed inside the prepared area.**

5. Allow the Primer to flash off (perform "touch test") and then align the PV laminate (with adhesive) over the prepared area.
6. PVL laminate should be bonded to the membrane with the temperature between 10°C and 40°C (50°F and 100°F). Lift up the laminate and double stick assembly about 300 mm (12") off of the roofing membrane, peel the release paper off of the double stick material approximately 150 mm (6") off the membrane and fold it under. Ensure that the laminate is aligned on the membrane, and that the PV laminate does not move on the membrane during the process. This is critical, as **the laminate's position will be fixed after the first six inches is bonded to the membrane.**
7. Stick the peeled end of the laminate assembly onto the membrane. Roll up the rest of the laminate assembly up to the stuck portion of the laminate. After the laminate assembly is rolled up on the membrane, one person should peel the release paper from the bottom of the laminate assembly as another person unrolls the laminate onto the prepared surface of the membrane. Stick the remaining laminate against the membrane, making sure the laminate is aligned properly on the prepared surface of the membrane.
8. After the laminate has been applied completely to the membrane surface, use a roller to press the center of the laminate against the membrane (See View 3). Then use a roller to press the laminate onto the membrane, starting from the center of the laminate, and rolling out to the edges of the laminate (See View 4).
9. Adhere the remaining PV modules using the procedure detailed above. Use a template to align the PV laminates so that they are parallel to each other. Top to top distance between two laminates facing each other is 3" (see detail on page 12).

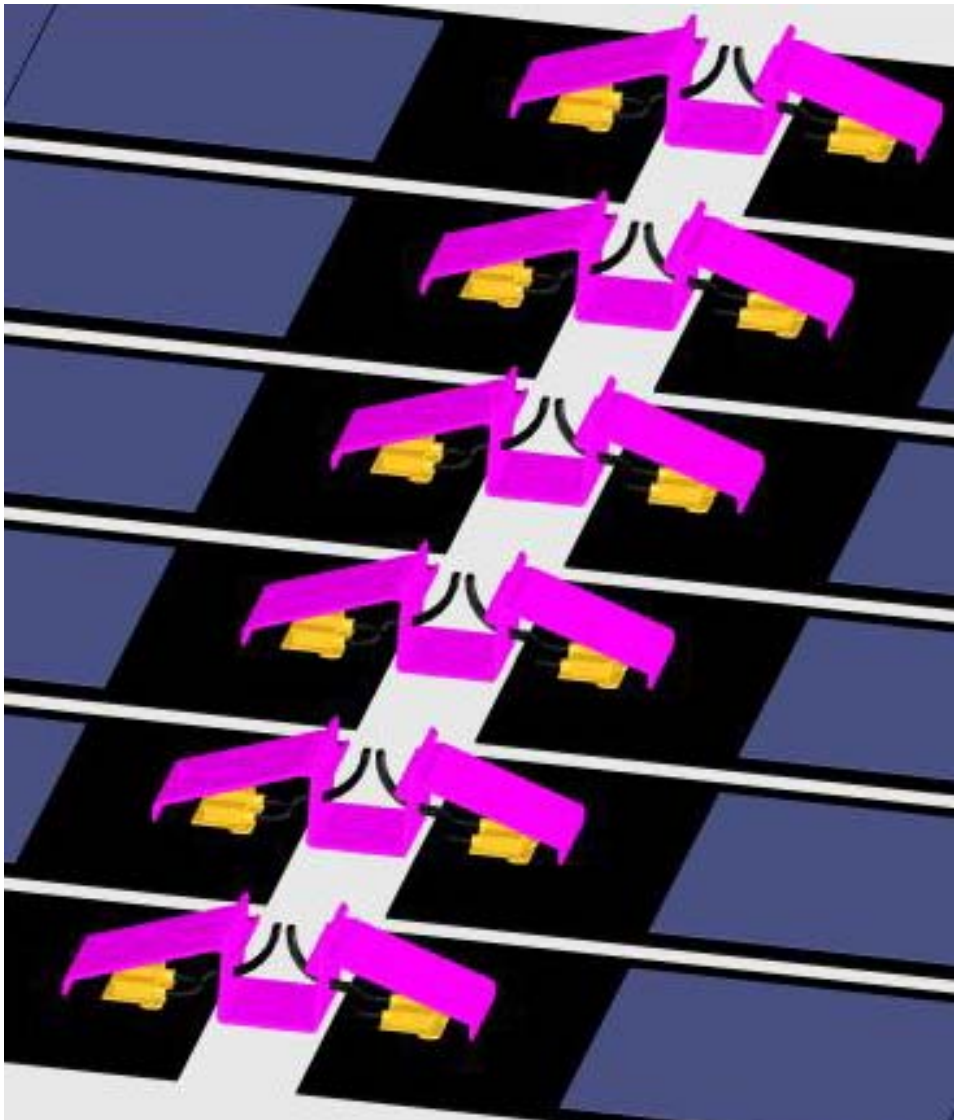


## SECTION #2

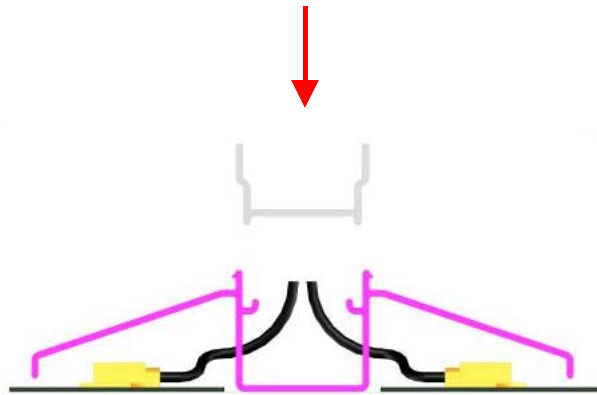
### 2.1 Detailed PV Laminate Wire Management System Construction Procedures

#### *Installation of the Wire Management System (Wire Cover Installation)*

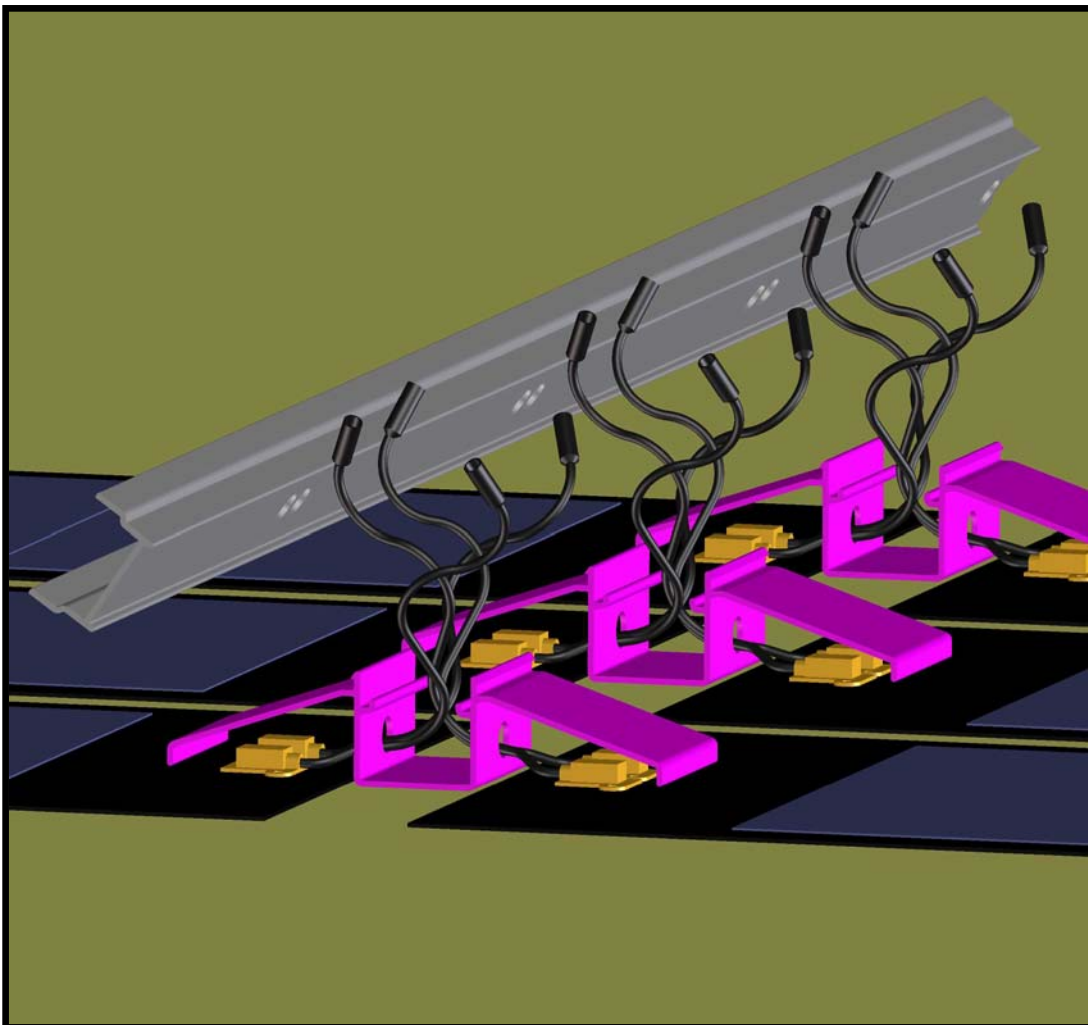
1. Make sure there is no adhesive in between the laminates
2. Thread the Quick Connect terminals through the holes in the base channels.



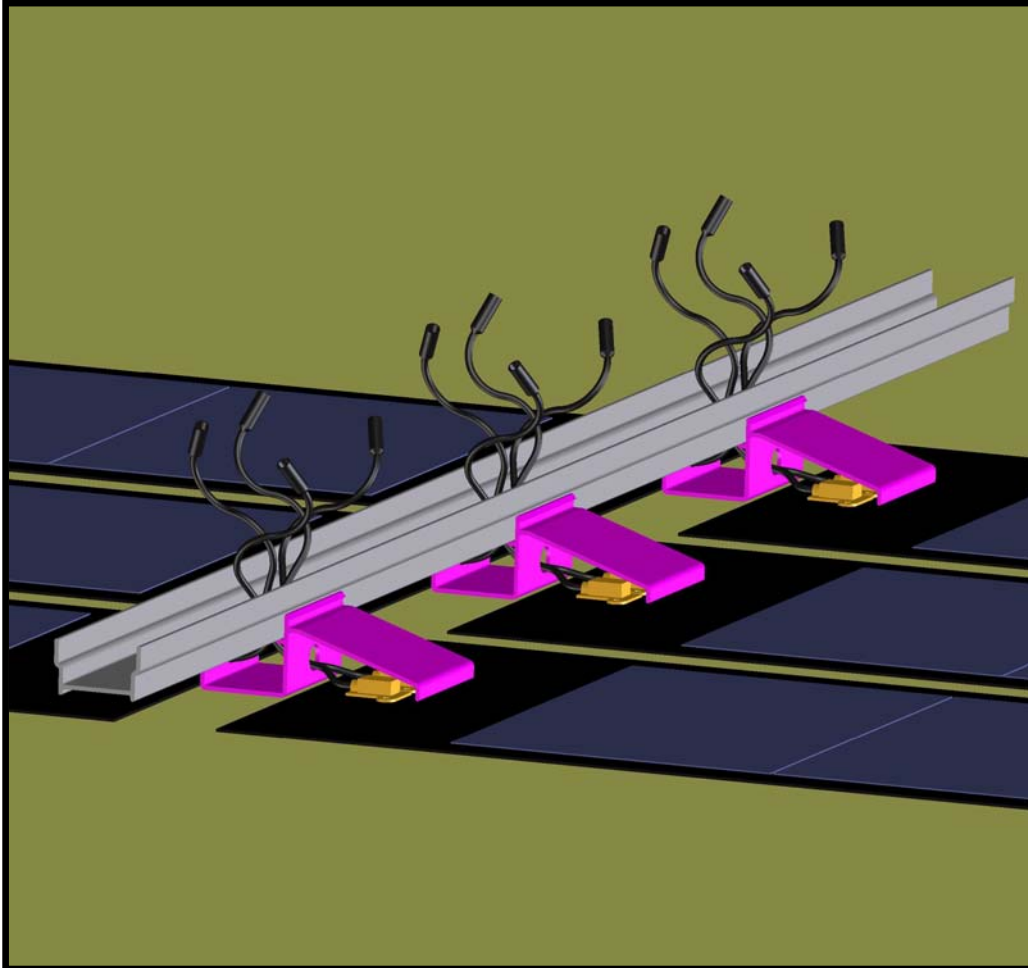
3. Place the raceway onto the base channels



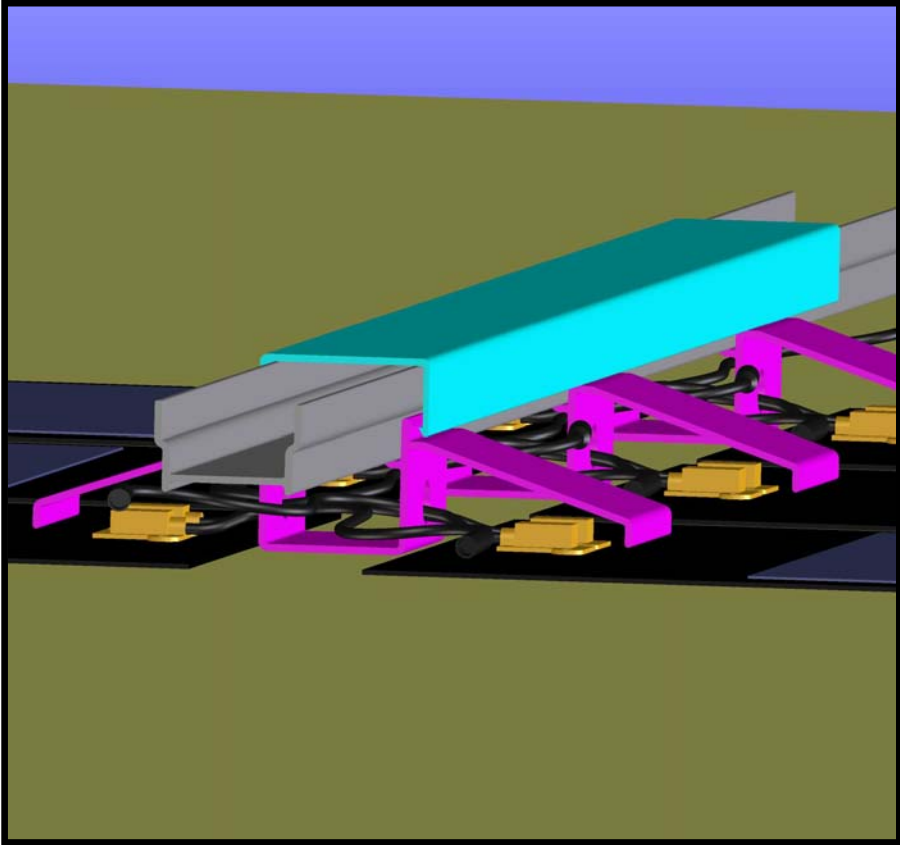
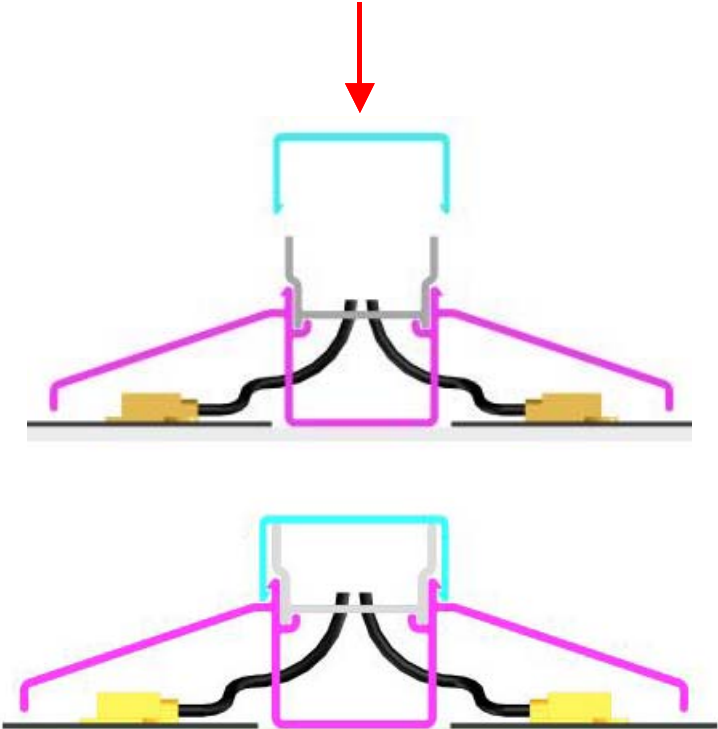
4. Indicate where the holes for each pair of laminate wires have to be made in the bottom of the raceway. One pair of wires (with Quick Connect terminals) will be threaded through each hole.
5. Remove the raceway and make the holes.



6. Re-position the raceway on the base channels.
7. Thread the quick connect terminals through the holes in the bottom of the raceway.

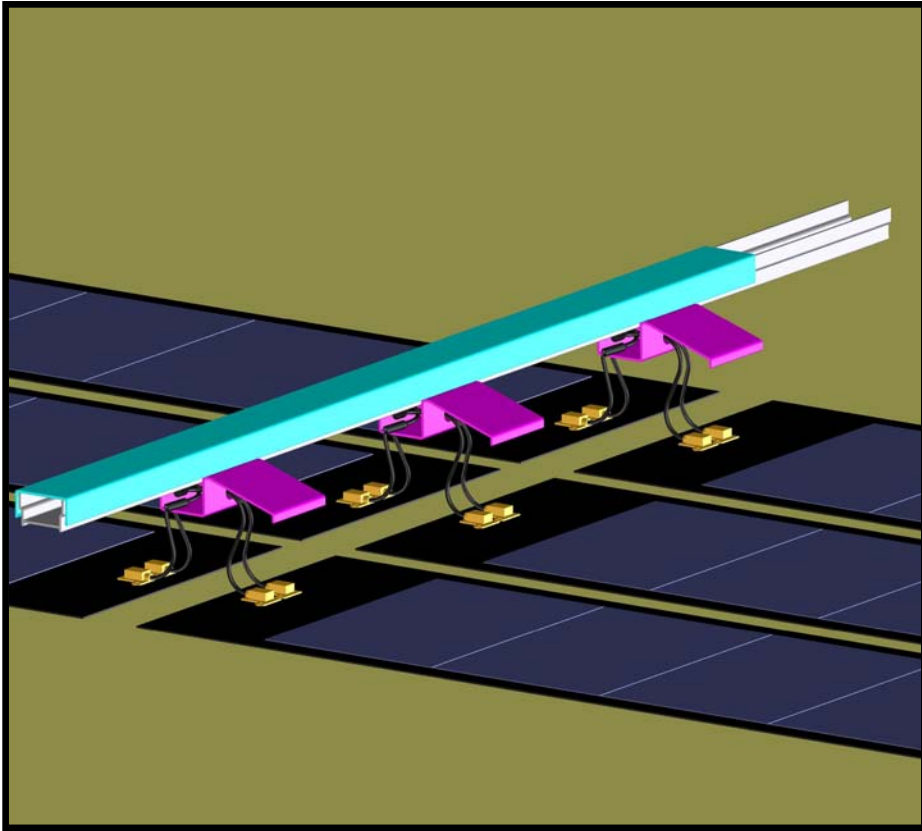


8. Plug the quick connect terminals together so that the modules are wired in series (positive to negative).
9. Snap the cover on the wire duct. This fixes the base channels in the correct position for the wire duct. This facilitates the bonding of the laminates. After attaching the base channels to the roof, the cover can be removed so the installer can interconnect the laminates together.

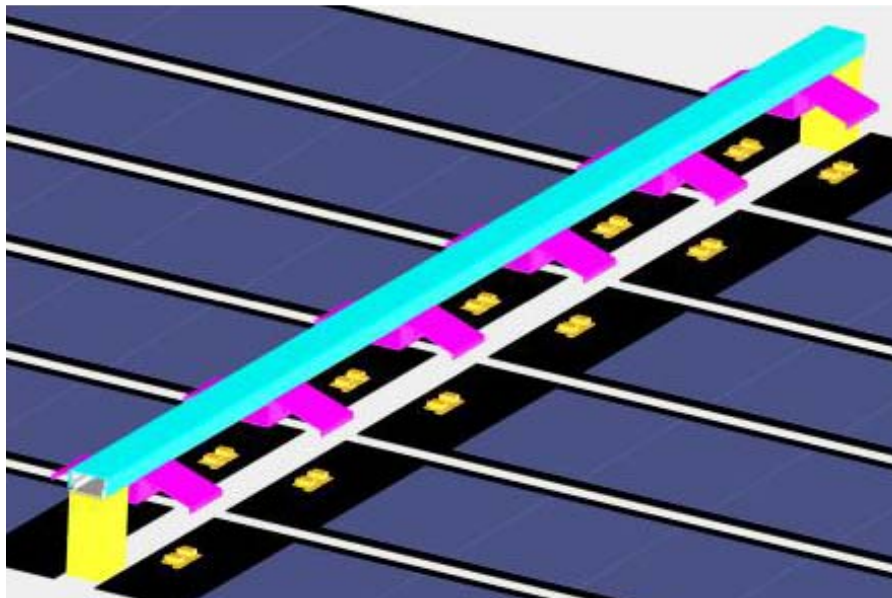




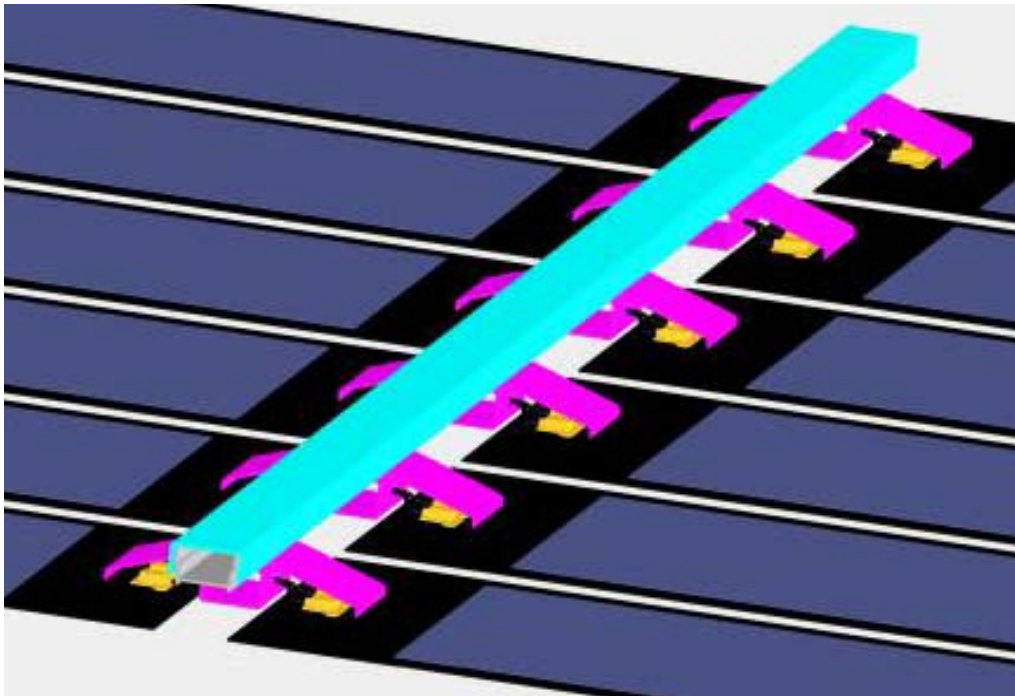
10. Lift raceway + cover + base channels about 4”.



11. Put raceway + cover + base channels on two supports

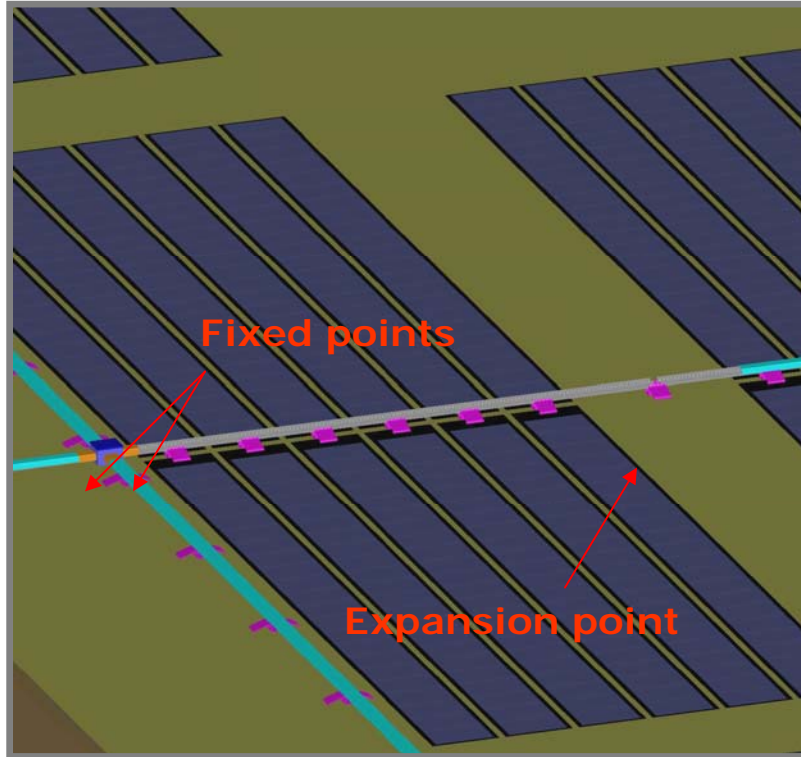


12. Apply the specific adhesive to roofing membrane in between the PV modules.  
(Recommended adhesive tapes are: For EPDM: ADCO SP-510 Black Rubber Adhesive Tape, For TPO: ADCO SP-605 White Rubber Adhesive Tape)
13. Remove supports
14. Adhere base channels to roofing membrane

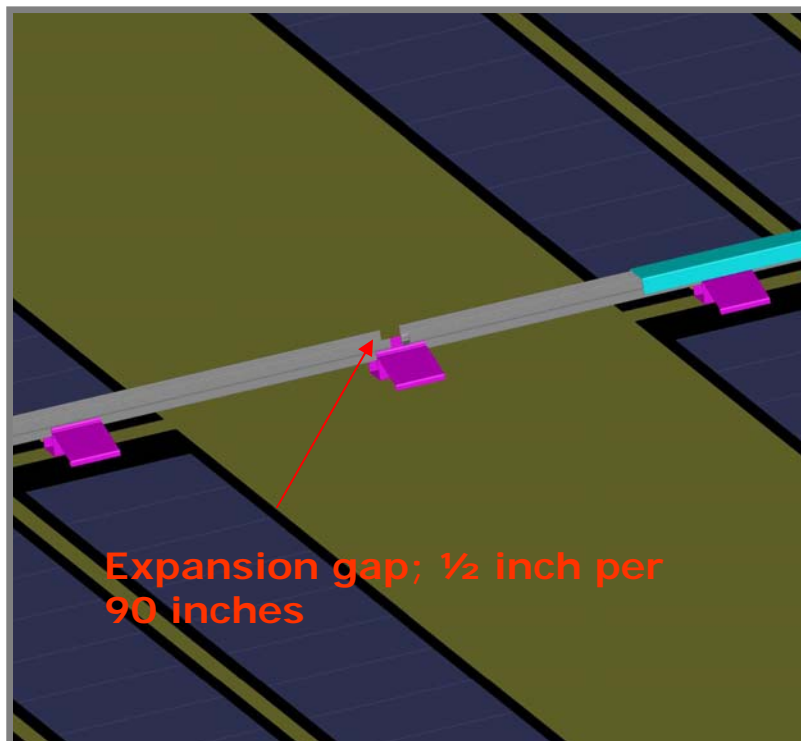


***Defining the Fixed Points and the Expansion Points for the Wire Duct***

The following diagrams show the expansion points for the wire ducts between two PV islands.

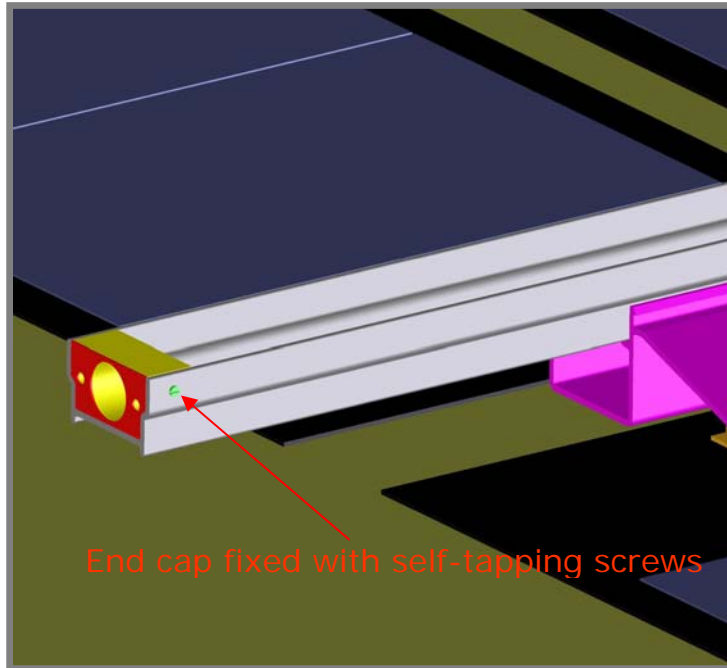


The expansion gap for the wire ducts will be  $\frac{1}{2}$  inch per wire duct length of 90 inches



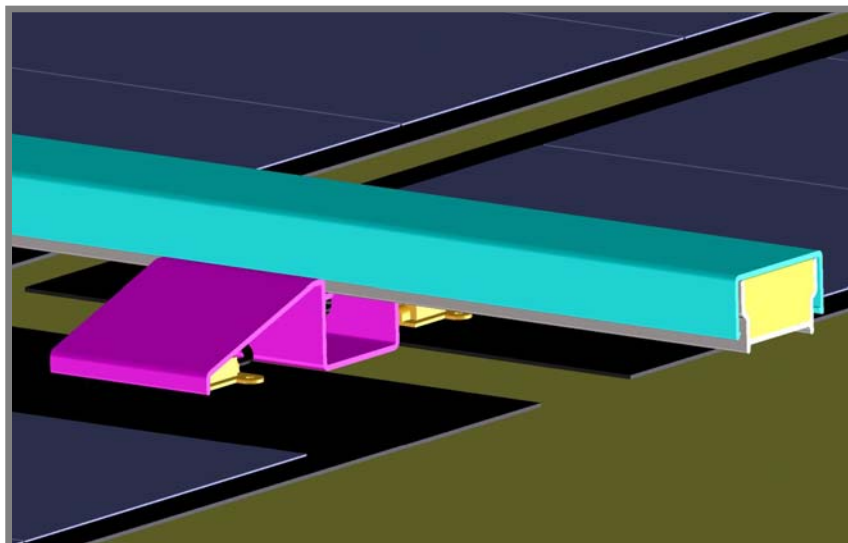
***Making Cross Connections and Preparing for the connection with a Combiner Box***

After attaching the wire duct and base channels to the roof, an end cap can be installed (fabricated by installer). To do this, you will remove or pull back the wire duct cover and slide an end cap into the wire duct and align with the end of the wire duct. Fix the end cap with self-tapping screws. An extra bit of sealant can be added.



***End Cap for a Free Wire Duct End***

In some cases, the installer will not need a junction box at the end of the wire duct (ex. the installer does not plan to have cross connections). The free end of the wire duct can be closed with an end cap (identical to the ones used before) but without the attachment holes.



## SECTION #3

### 3.1 Uni-Solar PVL Laminates with Quick Connect Terminals

Most PVL modules are supplied with factory-installed module interconnect wires with MC Quick Connect terminals. These terminals are marked “+” and “-” and will only fit into each other one way (See Addendum 1: Wiring *UNI-SOLAR* PVL Modules with Quick Connect Terminals).

It is required that additional strain relief for the wires is installed in the field. A mounting pad with cable tie is supplied with the laminates. The mounting pad comes with an adhesive that is used to bond the mounting pad to the steel pan just above the laminate. The plastic cable tie is then tightened around the wire to secure the connection from being pulled loose (see the Drawing on Page 23).

**NOTE: The Quick Connect terminals are to be used as interconnection devices only. They are not to be used as a means of disconnecting the solar array.**

PVL modules are wired together into strings of modules by plugging in a number of modules together (in “series”, positive to negative), to form a higher voltage string of modules. (600V max).

### 3.2 Wiring PVL Modules With Quick Connect Terminals

#### *Subject*

Proper use of the *UNI-SOLAR* Quick Connect Assembly, for use with modules that have factory-installed “Quick Connect” terminals on *UNI-SOLAR* PVL and Power Module interconnect wires.

#### *Introduction*

*UNI-SOLAR* Power Modules and PVL products can be supplied with “Quick Connect” terminals on factory-installed module interconnect wires. “Quick Connect” terminals are designed for exterior use and are UV resistant.

Although “Quick Connects” are well designed for fast connection of modules into groups (i.e. “strings”) of modules, **“Quick Connects” are not designed to be used as module disconnects**. For this reason, installers should procure and use the *UNI-SOLAR* Quick Connect Assembly for use with each series string of modules that utilize “Quick Connects”.

For each Quick Connect cable, there is a strain relief mounting pad and cable tie to provide strain relief. The mounting pad is installed in the field and adhered to the roofing material (not directly on the laminate surface) near the potted terminal cover located at the base of each quick connect cable.

### ***Installation Instructions***

Using the UNI-SOLAR Quick Connect Assembly and the instructions below, PV system installers are prepared for safely connecting PV module strings to balance of system components.

The UNI-SOLAR Quick Connect Assembly contains 2 pieces: a Male Cable Coupler Assembly and a Female Cable Coupler Assembly.

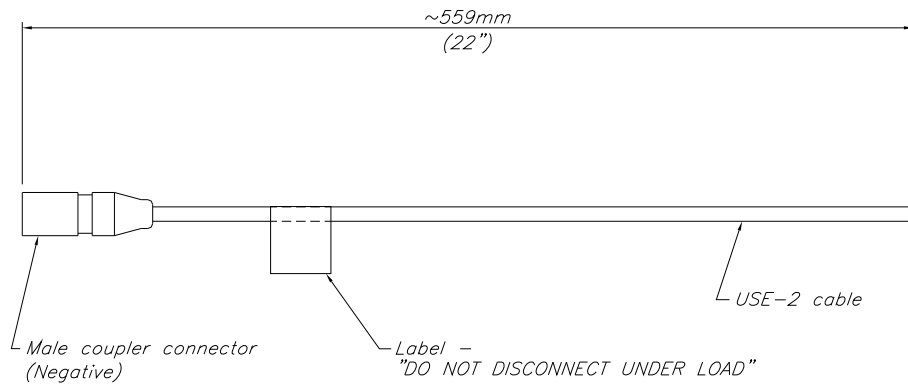
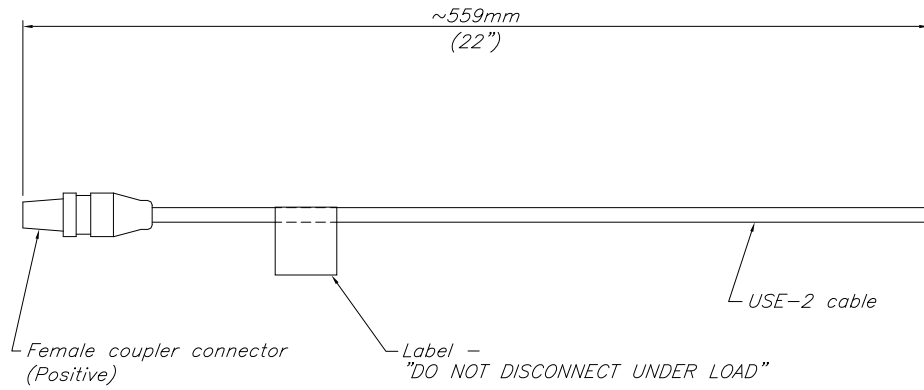
After series connecting (positive to negative) individual Power Modules or PVL's together into a group ("string") of Modules, there will be a male "Quick Connect" on one end of the string and a female "Quick Connect" on the other end of the string of modules.

1. Determine that the group ("string") of solar modules has the correct number of modules connected together (maximum system voltage 600 Vdc)
2. Install the Quick Connect strain relief pads and route the module interconnect wire through the cable tie loop. Tighten so that the wire is held firm
3. Find the male "Quick Connect" on one end of the string and the female "Quick Connect" on the other end of the string.
4. Attach appropriate outdoor-rated conductors to the ends of the *UNI-SOLAR* Cable Coupler Assemblies using standard wire terminals designed for exterior use.
5. Route positive and negative PV conductors to appropriate balance-of-system (BOS) components (ex. "Combiner Boxes").
6. Attach the *UNI-SOLAR* Male Cable Coupler Assembly on one end of the string.
7. Attach the *UNI-SOLAR* Female Cable Coupler Assembly on the other end of the string.
8. Refer to section 4.1 for the grounding of all metal roofing parts in close proximity to USE-2 source circuits.
9. PV source circuits must be terminated in a terminal box and then run in metal conduit prior to entering dwellings. See NEC for further guidance.

### ***Technical Information about Quick Connect Terminals:***

- 1) Withdrawal and Plug-In Force:  
For new Cable Couplers, the withdrawal force is  $\geq 50$  N and the insertion force is  $\leq 50$  N. The values may vary after a number of plugging cycles. Ensure you are not pulling on the potted terminal covers.
- 2) Rated Current:  
Maximum rated current is 8 amps for the *UNI-SOLAR* Male and Female Cable Coupler Assemblies.
- 3) Maximum System Voltage:  
Maximum voltage for a *UNI-SOLAR* PV system and the *UNI-SOLAR* Male and Female Cable Coupler Assemblies is 600 VDC.
- 4) Cable Type For Quick Connect Assemblies:  
4mm<sup>2</sup> (12 AWG) cable UL RHH or RHW2 PV Wire 90°C wet or dry 600V, TUV Photovoltaic wire 110°C @ 1000V.

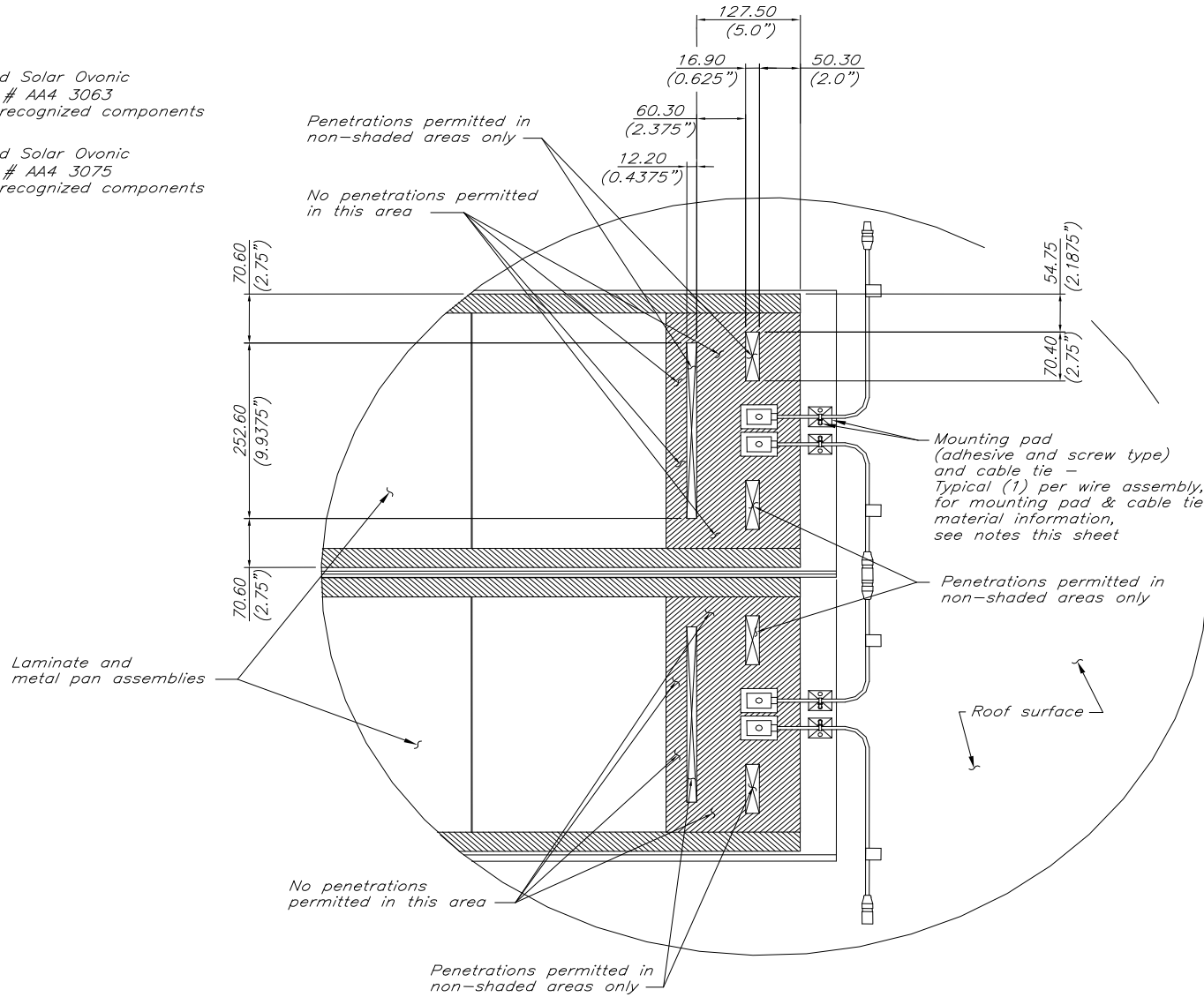
## Quick Connect Assemblies: Drawings and Bill of Materials



Notes:

Cable ties – United Solar Ovonix  
part # AA4 3063  
U.L. recognized components

Mounting Pad – United Solar Ovonix  
(Adhesive and screw type)  
part # AA4 3075  
U.L. recognized components





## SECTION #4

### 4.1 General Wiring Procedures for PV Laminate Roofing Systems

#### *Wire Selection*

- 90°C, wet rated conductors are necessary. If modules interconnect wires are exposed to weather and sunlight, use conductor type USE-2, or USE. If module interconnect wires and/or cables going from the modules to the combiner box are to be run inside of a wire chase or under a wire cover, you can use RHW-2, THWN or XHHW-2 conductors.
- Temperature de-rated ampacity calculations for the DC side of your PV system should be based on 156% of the short-circuit current ( $I_{sc}$ ), and the de-rated ampacity must also be greater than the rating of the over-current device. Refer to the NEC Article 690.

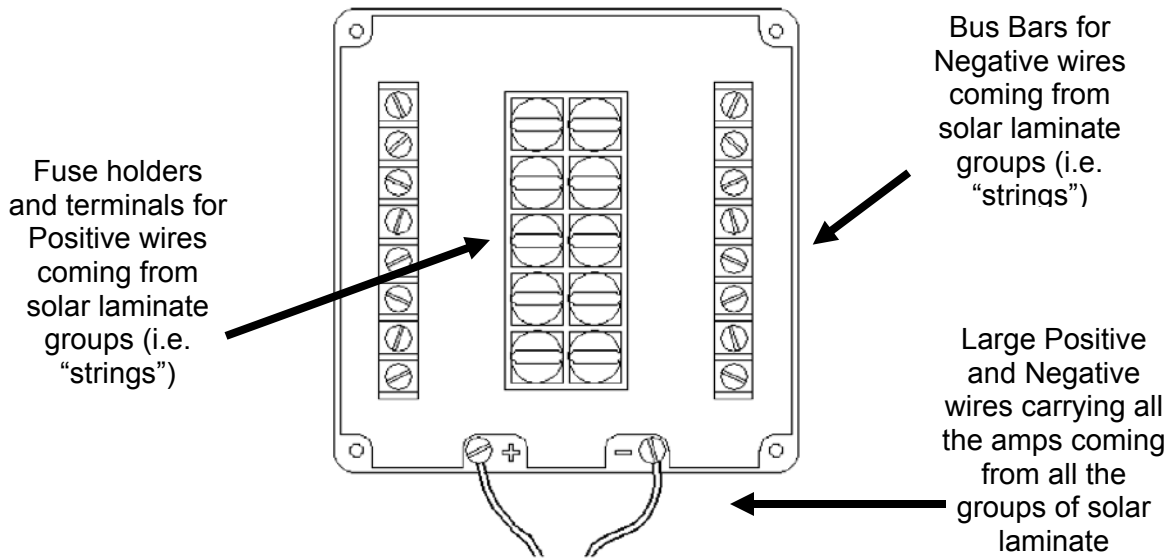
#### *Wiring UNI-SOLAR PV Laminates with Quick Connect Terminals*

- *UNI-SOLAR* PV Laminates are supplied with “Quick Connect” terminals on factory-installed module interconnect wires.
- “Quick Connect” terminals are designed for exterior use and are UV resistant. By eliminating the need for conduit and by utilizing latching-type, male / female style terminals, *UNI-SOLAR* PV Laminates supplied with “Quick Connects” offer increased installation speed and installer productivity.
- Although “Quick Connects” are well designed for fast connection of Laminates into groups (i.e. “strings”) of modules, **“Quick Connects” are not designed to be used as module disconnects.** For this reason, installers should procure and use the *UNI-SOLAR* Quick Connect Assemblies for use with each series string of modules that utilize “Quick Connects”.2
- After series connecting (positive to negative) individual PV Laminates together into a group (“string”) of Laminates, there will be a male “Quick Connect” on one end of the string and a female “Quick Connect” on the other end of the string of modules.
  1. Determine that the group (“string”) of solar modules has the correct number of modules connected together (maximum system voltage 600 Vdc).
  2. Find the male “Quick Connect” on one end of the string and the female “Quick Connect” on the other end of the string.
  3. Measure the distance from the end of the Laminate string to the Combiner box where the positive and negative wire connections will be terminated. Be sure to follow the wire tray or conduit run exactly while determining the length of the wire.

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4. Attach one *UNI-SOLAR* Cable Coupler Assembly to one end of an appropriate outdoor-rated conductor that will be used for the positive wire run to the combiner box. Repeat for the negative wire using the opposite type *UNI-SOLAR* Cable Coupler Assembly.
5. Route positive and negative PV conductors to appropriate balance-of-system (BOS) components (ex. "Combiner Boxes").
6. Attach the *UNI-SOLAR* Male Cable Coupler Assembly I to one end of the string.
7. Attach the female Cable Coupler Assembly to the other end of the string.

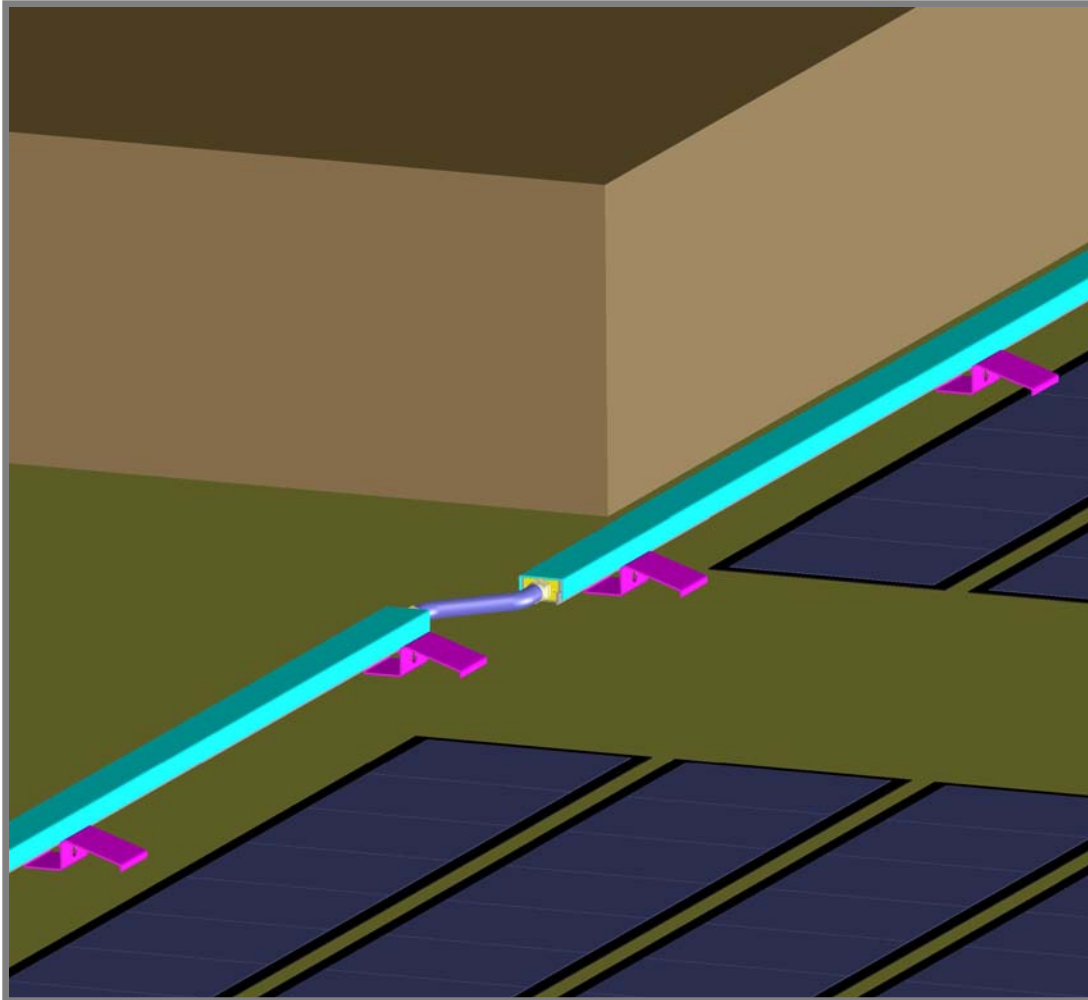
- Laminates can be configured using series wiring, parallel wiring, or a combination of series and parallel wiring.
- When Laminates are wired in series, the volts will add up while the amps will not. When Laminates are wired in parallel, the amps will add up while the volts will not.
- After the series wiring is complete, parallel wiring can begin. Parallel wiring is accomplished by connecting the positive of one laminate to the positive of another laminate, then connecting the negative of the first laminate to the negative of the second laminate.
- Commonly, a combiner box is used to accomplish parallel wiring.



- The Combiner box collects the series strings and contains the fuses and blocking diodes. Commonly, the combiner box is mounted close to the array or by the inverter.
- With outdoor installations, care must be taken to ensure that rain cannot run directly into the boxes (via the cable glands or box cover). Mount at least 20 inches (1/2 meter) off the roof surface and out of direct sun (if possible).
- After the PV Laminates are bonded to the roof and a location for the Combiner Box(s) is determined, wire covers will be used to route the solar array wires from each individual group to other groups and/or to the Combiner Box(s).

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When wire ducts have to shift around equipment on the roof, one possible solution would be to use a flexible conduit and fittings fixed to standard end caps (see illustration below).



### ***Grounding***

- Section 690.5 of the NEC requires that systems with PV modules on the roof of a dwelling have ground fault protection equipment.
- The equipment-grounding conductor will need to be bonded to earth via a ground rod. The conductor can be bare copper or insulated with green colored insulation. The conductor should be sized according to Table 250-122 in the NEC.
- PV source circuits must be terminated in a terminal box and then run in metal conduit prior to entering dwellings. See NEC for further guidance
- Please refer to the National Electric Code for further guidance related to all wiring associated with the photovoltaic system.

## **4.2 Maintenance**

### ***PV Laminates on Membrane Roofing***

- When working on a roof, ensure you are properly tethered and that your safety equipment is in safe operating condition.
- When working on the PV Laminates, always wear electrical gloves rated for the maximum rated system voltage (i.e. 600 VDC), disconnect all energy sources (i.e. battery and/or utility) and short-circuit the output of the PV Laminates.
- Periodically check PV Laminate wiring connections for tightness and corrosion. The best time to check is just before and/or just after the winter (or rainy) season.
- Generally, a good rain is sufficient to clean the PV Laminates. However, in dusty arid locations the PV Laminates can be cleaned with water or mild soap and water. Do not use abrasive soaps or solvents.
- Do not spray water directly at leading edge of the PV Laminates. Use caution when cleaning PV panels, as the combination of water and electricity may present a shock hazard. Always wear electrical gloves and avoid cleaning the panels in the middle of the day.

### ***System Commissioning and Troubleshooting***

- With disconnect switches closed, record all system meters and status indicators.
- With the multi-meter, check array voltage at each group of PV Laminates and current at the Combiner Box or other convenient place within the system.

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- Check for open circuit breakers or blown fuses.
- Open disconnect switches and use your multi-meter to **confirm that the power is actually cut off.**
- Check for loose wires or connections at all solar system array controller (voltage regulator), Combiner Boxes, and/or other Junction Boxes within the system.
- Remove cabinet covers and visually inspect all Disconnect Switches and electronic equipment wiring.
- Check array current between the Laminate strings and the combiner box and between the combiner box and the balance-of-system components if you have a clamp-on amp meter (i.e. if you can make the measurement without disconnecting or cutting the current carrying conductors).
- Close all disconnect switches and make sure loads are operating as designed.
- Clean balance-of system components (i.e. inverters, disconnect enclosures, etc.) and loads once a year or as required.
- Confirm that no new loads have been added to the system and that loads are operating for the specified number of hours per day.

### 4.3 PVL Installation Check List and Final Report

The purpose of this Report is to certify that the undersigned installer has completed installation of *UNI-SOLAR* PVL Laminate described below in accordance with the manufacturer's installation guidelines and has fully complied with the PVL bonding instructions.

To ensure that the PVL laminate was properly installed, it will be required that all PVL Installers copy the Installation Checklist and Final Report from this manual, fill in the Checklist and Report after installation of the product at any given site. The Check List and Report is then signed, dated and returned to:

United Solar Ovonic LLC  
BIPV Applications Engineering Department  
3800 Lapeer Road  
Auburn Hills, MI 48326

**Installation Location:**

Customer / Project Name:.....

Site Address:.....

Customer Telephone / Email: .....

**Application of the PVL Product:**

QUESTION	YES	NO
1. If the PVL application will take place on an existing roof, were the pans washed with a pressure sprayer and cleaning solution (ex. TSP, Detergent and Water) to remove collected dirt, pollen, grime etc.?		
2. Were the pans washed with Isopropyl Alcohol (90% alcohol to 10% water) before application of the laminates?		
3. Was the pan temperature at least 50° F during the bonding process?		
4. Were all laminates aligned properly on the pans?		
5. Did all the laminates adhere to pan completely?		
6. Was every square inch of the laminate pushed down to the metal pan surface with the laminate roller to ensure a complete bond to the metal pan?		
7. Was the J-box or Quick Connect Terminals aligned properly?		
8. Did the laminates come with Quick Connect Terminals, a standard J-Box or a J-Box w/ Quick Connects?		
9. How long did it take (on average) to bond the laminate and J-Box to the pan?		Minutes

**Post-Installation:**

QUESTION	YES	NO
1. Did the roofer install the pans properly?		
2. Was there any damage to the solar module (laminate) during installation?		
3. Are any ripples or other defects in the PVL application seen from the ground?		
4. Is the J-Box or Quick Connect wiring adequately protected from UV by metal roofing trim (or an approved wire cover)?		



**System Information:** which products should be added?

QUESTION	
1. What is the operating voltage of the PV array?	
2. Which laminates were installed at this site (PVL-29, PVL-58, PVL-64, , PVL-68, PVL-116, PVL-128, PVL-136 or PVL-144)?	
3. How many PVL laminates were installed on the UL Listed Roofing System at this site?	
4. What type of inverter was installed at this site?	
5. What type (if any) of battery was installed at this site? What is the total amp-hour capacity of the battery?	

**Note to Installer:**

The quality and acceptance of PVL installations are the prime responsibility of the installer. United Solar Ovonic LLC reserves the right to inspect any and all installations to verify the accuracy of this report. Providing inaccurate or misleading information will cause immediate cancellation of the installer’s certification.

**Installer:**

Signature:.....Date:...../...../.....

Name:.....

Address.....

**Telephone:** .....

**Email:** .....

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