MiaSolé

FLEX™ Application Guide for Steep Slope Metal Roofs

Lightweight Photovoltaic Modules for
Steep Slope Standing Seam Metal Roofing

FLEX™ Series Modules

FLEX-02N & FLEX-02NS

MiaSolé Hi-Tech

Santa Clara, CA

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Please see the MiaSolé warranty statement for more information.

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1.0 Safety

- Electrical installation of the FLEX series PV modules and system shall be conducted by a qualified solar integrator and/or electrical professional.
- Mechanical installation of the FLEX series PV modules shall be performed by qualified solar integrator and/or roofing professional.
- FLEX series PV modules generate power whenever exposed to light. Follow applicable NEC guidelines, avoid contact with electrically active parts and be sure to isolate live circuits before tempting to make or break any connections.
- Do not artificially concentrate sunlight on these modules.
- Always use proper electrical safety practices, insulated tools and protective equipment when making electrical connections to avoid electric shock.
- Adhere to all applicable national and regional codes (fire, electrical, building).
- Tools and working conditions must be dry. Do not install or handle modules when they are wet or in periods of high wind.
- Never connect or disconnect the FLEX module from the inverter or combiner box while the inverter is connected to the main grid.
- PV modules produce DC current when exposed to light, when installing FLEX modules during day time, fully cover the front of the modules with an opaque (non-transparent) tarp during installation.
- Ensure all cable connections, and connectors, are fully seated and secured (no gaps between contacts) and in good condition (no splitting, no corrosion, nor other contaminations).
- Do not use damaged modules and do not disassemble modules. Contact sales@miasole.com concerning damaged modules.
- There are no user serviceable parts in the module. Do not attempt to repair, alter, or remove any part of the module.

2.0 Introduction

In introducing the FLEX™ modules, MiaSolé is a pioneer and leading manufacturer of copper indium gallium selenide (CIGS) thin-film photovoltaic solar modules.

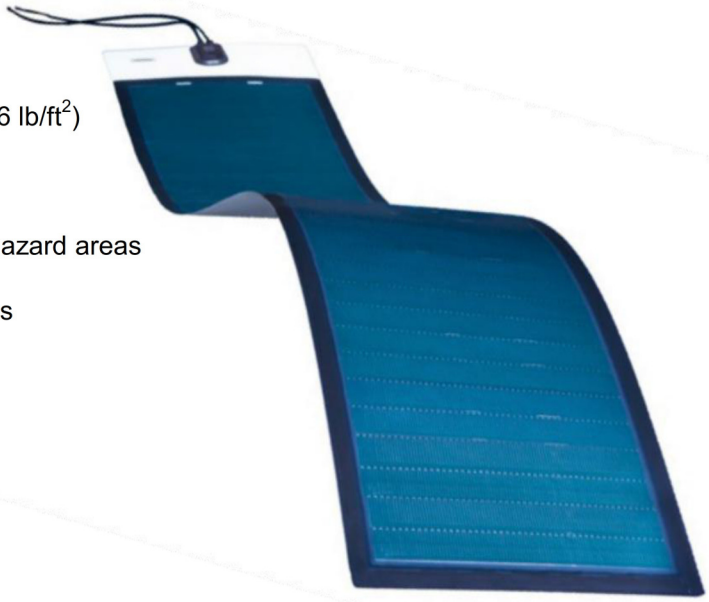
The new CIGS based MiaSolé FLEX™ modules are flexible and lightweight. The FLEX "N" Series PV modules are for Building Integrated PV (BIPV) installations on steep slope standing seam metal commercial and residential roof systems.

The FLEX modules come with a full coverage factory-applied PVA 600BT peel-and-stick self-adhesive backing.

FLEX module advantages are fewer parts, reduced material management, less inventory control, lower material logistics, simpler installation process, faster installation time requiring less manpower and fewer roof top penetrations

KEY FEATURES

- Record efficiency levels in a flexible form factor
- Low installed weight at less than 2.9 kg/m^2 (< 0.6 lb/ft^2)
- Non-penetrating, ballast or racking required
- Applicable for high wind load and high seismic hazard areas
- Bypass diodes reduce PV system shading losses



RELIABILITY AND SAFETY

- UL 1703 (Fire Class C)
- IEC 61730 -1/2 , IEC 61646

WARRANTY

- 5 year workmanship
- 10/25 year warranty against power loss

2.1 Glossary of Terms

FLEX – Refers to the MiaSolé FLEX-02N & 02NS series modules.

PVA 600BT – Refers to the ADCO HelioBond PVA 600BT bonding self-adhesive.

WMS – The Wire Management System is a roof mounted covered tray or conduit system that protects the string and homerun wire conductors.

IPA (2-propanol isopropyl alcohol): Used to clean metal surface prior to bonding FLEX modules to the metal roof panel. Alcohol shall be diluted with 10% water by volume.

2.2 Product Description

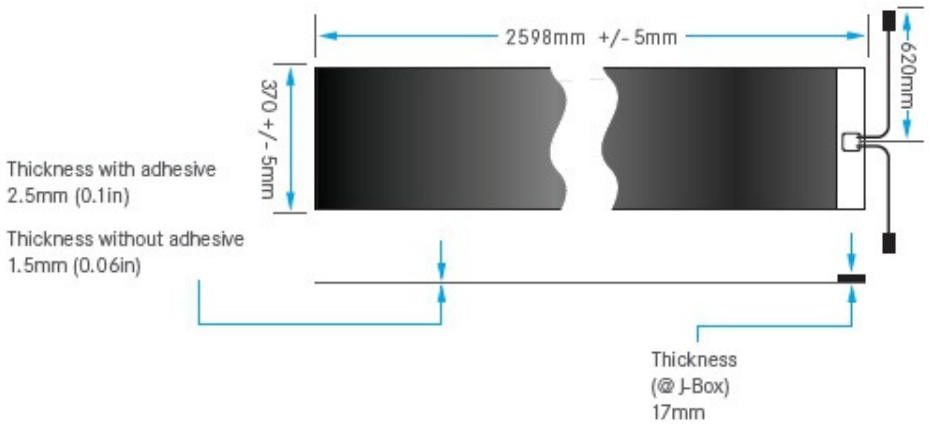


Figure 1 . MiaSolé FLEX-02N Series Module

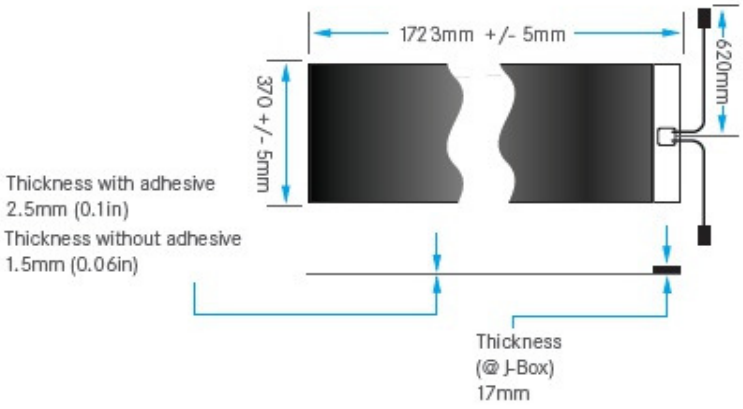


Figure 2. MiaSolé FLEX-02NS Series Module

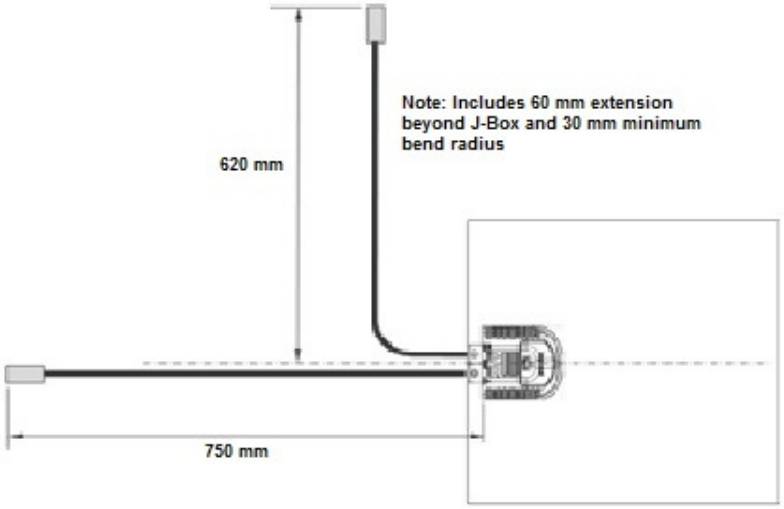


Figure 3. MiaSolé FLEX-02N & FLEX-02NS Series Module Cable Length

Physical and Mechanical Specifications		
Product	**FLEX-02N** **110N 115N 120N 125N 130N**	**FLEX-02NS** **65NS 70NS 75NS 80NS 85NS**
Length	2598 mm ±5 mm (102.3 in. ± 0.2 in)	1723 mm ± 5 mm (67.8 in. ± 0.2 in)
Width	370 mm ±5 mm (14.6 in. ± 0.2 in)	370 mm ±4 mm (14.6 in. ± 0.16 in)
Thickness	2.5 mm ± 0.5 mm (with adhesive) (0.1 in. ± 0.02) Max. 17 mm (0.67 in.) @ Junction Box	2.5 mm ± 0.5 mm (with adhesive) (0.1 in. ± 0.02) Max. 17 mm (0.67 in.) @ Junction Box
Weight (module with adhesive)	2.7 kg (5.9 lb)	1.9 kg (4.1 lb)
Weight/Area (module with adhesive)	2.9 kg/m^2 (0.6 lb/ft^2)	2.9 kg/m^2 (0.6 lb/ft^2)
Weight (module without adhesive)	1.96 kg (4.32 lb)	1.37 kg (3.01 lb)
Weight/Area (module without adhesive)	2.04 kg/m^2 (0.42 lb/ft^2)	2.14 kg/m^2 (0.44 lb/ft^2)
J-Box Rating / Connector Rating	IP68 / Amphenol H4	
Cell Type	Copper Indium Gallium Diselenide (CIGS)	
Static Load	5400 Pa	
Bend Radius	508 mm (20 in.) minimum	
Certifications	UL 1703, IEC 61646, IEC 61730-1 and 2	

2.3 Electrical Data

Electrical Performance*	FLEX-02 110N	FLEX-02 115N	FLEX-02 120N	FLEX-02 125N	FLEX-02 130N
Rated Peak Power (+5/-0 W) – P_{MPP} (W)	110	115	120	125	130
Maximum Power Voltage – V_{MPP} (V)	28.90	29.70	30.50	31.30	32.00
Maximum Power Current – I_{MPP} (A)	3.81	3.87	3.93	4.00	4.06
Open Circuit Voltage – V_{OC} (V)	37.10	37.60	38.10	38.60	39.10
Short Circuit Current – I_{SC} (A)	4.50	4.52	4.53	4.55	4.57
Length (m)	2.598				
Maximum Series Fuse Rating (A)	10 A				
Maximum System Voltage (IEC/UL)	1000 V / 600 V				
Fire Rating	Class C				

Electrical Performance*	FLEX-02 65NS	FLEX-02 70NS	FLEX-02 75NS	FLEX-02 80NS	FLEX-02 85NS
Rated Peak Power (+5/-0 W) – P_{MPP} (W)	65	70	75	80	85
Maximum Power Voltage – V_{MPP} (V)	17.70	18.50	19.30	20.00	20.80
Maximum Power Current – I_{MPP} (A)	3.67	3.79	3.89	3.99	4.09
Open Circuit Voltage – V_{OC} (V)	23.20	23.70	24.30	24.80	25.30
Short Circuit Current – I_{SC} (A)	4.47	4.49	4.52	4.55	4.58
Length (m)	1.723				
Maximum Series Fuse Rating (A)	10 A				
Maximum System Voltage (IEC/UL)	1000 V / 600 V				
Fire Rating	Class C				

* At Standard Test Conditions: 1000 W/m^2, 25º C cell temperature, AM 1.5 Spectrum. MiaSolé module nameplate ratings reflect both the initial and stabilized performance of the product to within the stated tolerance of ± 10%.

3.0 Handling & Shipping of Modules

3.1 Handling

The following general guidelines are to be followed to ensure a safe and proper installation including handling and storage of the FLEX module. Failure to follow these instructions may result in bodily injury, damage to the FLEX module, or damage to property. Failure to comply with these instructions will invalidate the MiaSolé Limited Warranty for FLEX modules. If there are any questions, please contact sales@miasole.com .

- Do not use the J-Box or connecting cables as handles to lift or carry the FLEX modules.
- Use caution when handling FLEX modules in windy conditions on the roof to avoid personal injury and potential damage to the FLEX module.
- While working on the roof use all necessary barriers, safety equipment, and tethers as required by OSHA or local guidelines.
- FLEX modules have a smooth top surface. Use caution when water is on top of the surface as modules will lose traction.
- Do not stand or step on FLEX modules. Use protective footwear (non-penetrating) to avoid damaging or scratching the modules.
- Do not crease or bend the FLEX modules over sharp edges.
- Do not apply paint, solvents or adhesives to the top surface of the FLEX modules.
- Only ship FLEX modules in MiaSolé factory supplied packaging materials and crates.
- Keep all electrical contacts clean and dry.
- Do not place FLEX modules face-down in direct contact with abrasive surfaces.
- FLEX modules may NOT be cut, penetrated, or field modified in any way. Cutting the modules could result in exposed conductors, will void the warranty, and could result in a shock hazard.

3.2 Product Storage

The FLEX module should be stored in a climate-controlled warehouse environment until needed in the field:

- The FLEX modules should be kept in a dry, clean warehouse-type facility prior to installation, with ambient temperatures at or below 24°C (75°F).
- FLEX modules with factory applied ADCO PVA 600BT adhesive have a 'minimum shelf life of one year when stored at or below 24°C (75°F) (as per ADCO 600BT datasheet).
- Onsite the FLEX modules should be stored in a closed storage container and not be exposed to excessive moisture, heat or cold.
- On the roof, place FLEX modules on pallets and fully protect from exposure to moisture and direct sunlight. Leave protective packaging in place until FLEX modules are ready to be installed.
- Do not store FLEX modules on the roof or outdoors overnight.

3.3 Shipping Crate

The FLEX modules are shipped in cardboard crates with a wooden base (pallet) for forklift handling.

- There are 15 FLEX modules per crate and 10 crates per pallet.
- Store in original crates oriented flat and not on its edge.
- Do not stand or walk on FLEX module crates.
- Do not use box cutters / knifes to cut the straps or wraps – use cutting pliers.
- For shipping or storage, no more than one fully-loaded pallet should be stacked one on top of the other.
- Crates must not be stacked more than 5 crates high (refer to **Figure 4**).

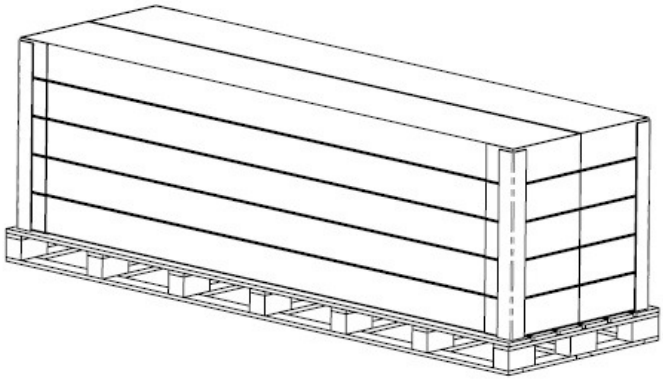


Figure 4. Standard pallet with 10 crates.

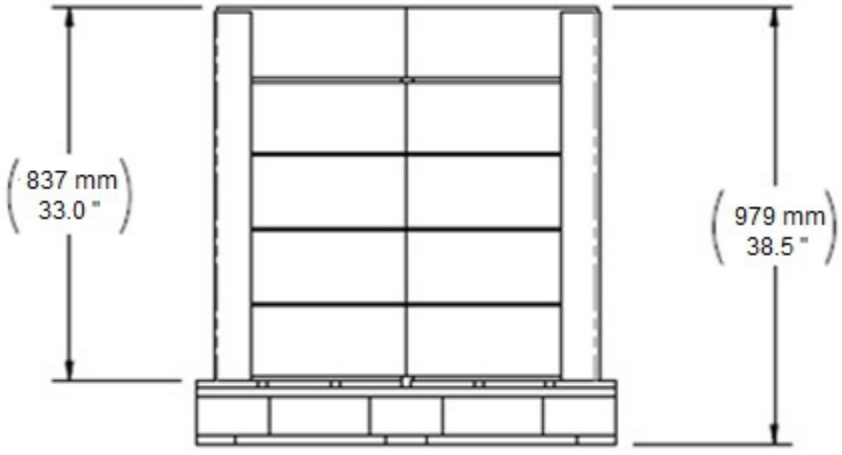


Figure 5. Height dimensions of fully loaded pallet.

Refer to the crate dimensions and weight specifications to insure that the lifting implemented is suitable for handling the pallet. The crate shipping weight and dimensions are as follows:

	FLEX-02N **110N 115N 120N 125N 130N**		**FLEX-02NS** **65NS 70NS 75NS 80NS 85NS**	
	Dimensions (Length x Width x Height)	**Weight**	**Dimensions** (Length x Width x Height)	**Weight**
Fully loaded pallet (10 crates + pallet) [150 total modules]	2959 mm x 940 mm x 979 mm (116.5“ x 37“ x 38.5“)	606 kg (1335 lbs)	2057 mm x 940 mm x 979 mm (81“ x 37 “ x 38.5 “)	370 kg (816 lbs)
Crate [with 15 modules]	2901 mm x 424 mm x 168 mm (114.2“ x 16.7“ x 6.6“)	57 kg (125 lbs)	1981 mm x 413 mm x 165 mm (78“ x 16 ¼“ x 6 ½ “)	36 kg (79 lbs)

4.0 FLEX Application Guidelines

The bonding / installation guidelines below are provided as an outline only and are meant for clean, dry standing seam metal roof surfaces. Follow these guidelines to maintain the reliability and warranty of the FLEX modules and the roof. Reapplying FLEX modules that were previously bonded to a roofing surface will void the warranty of the modules.

4.1 Environmental Considerations

FLEX modules are designed and tested to withstand strenuous environmental conditions for more than 25 years. In addition, FLEX modules are UL and IEC certified for safety and performance-code compliant for global markets. FLEX modules should be installed in locations that meet the following requirements:

- FLEX modules must not be immersed in water or exposed to continuous water streams or flows (e.g., from fountains, sprinklers).
- FLEX modules should not be exposed to extremely corrosive chemicals or flammable vapors and gases (e.g., emissions from manufacturing plants or other sources).
- FLEX modules must not be mounted at a site where it may be subject to direct contact with salt water.
- Installed location should be planned to avoid areas where wind uplift is at its maximum such as corners or roof edges. Refer to ASCE 07.
- The ambient temperature at the time of installation should be between 4°C - 49°C (40°F - 120°F). If the temperature is higher than 49°C (120°F) the polymer film release liner may be difficult to remove from the PVA 600BT (peel-and-stick adhesive) and the metal roof panel surface may exceed the adhesive application temperature. In hotter climates, the FLEX modules should be stored in a shaded area prior to installation to prevent excessive heating of the adhesive. If the temperature is lower than 4°C (40°F) the adhesive may not adhere properly to the roofing surface.

4.2 Roofing Considerations

4.2.1 Module Pre-Integration and On-Site Attachment

Pre-Integration

- Factory laminated to the metal roof panel by the metal roof system manufacturer and delivered to the job site ready to be installed on the roof by the manufacturers approve contractor.

On-Site Attachment

- To the roofing contractor for on-site bonding to the metal roof panel prior to installing the metal roof panel onto the new roof structure.

4.2.2 Rooftop Guidelines

- The FLEX module is designed for installation on or over approved steep sloped metal roof systems. For applications on corrugated and R-panel metal roof systems contact sales@miasole.com .
- On pre-approved existing metal roofs, the FLEX module may be installed on the existing metal roof.
- Installer may use approved in field roll-formed metal roof panels.
- Do not install the FLEX modules so that the building or other structure, or other systems or components, exert damaging mechanical or electrical influences on the FLEX modules.
- FLEX module installation should not exceed roof system UL and FM fire rating slope limitations. FLEX modules can be installed on roof slopes of 15 to 60 degrees (3/12 to 21/12-roof pitch) measured from horizontal. Contact sales@miasole.com for roofs under 3/12.
- FLEX modules placement should be set back a minimum of 0.9 meters (3 feet) from the lower roof perimeter edge. The setback reduces the effect of wind uplift forces at the building perimeter and corners on the solar array.
- When working 1.8 meters (6 feet) or closer to the roof edge, OSHA requires specific fall protection action to come into effect.
- The metal roof assembly must meet roof manufacturer's minimum requirements for direct PV module bonding. Roof manufacturer's approved new metal roof systems are recommended. Refer to roof manufacturer's recommendations and metal roof system limitations for direct PV module bonding to *existing m*etal roof systems.

4.2.3 Acceptable Substrates

The following metal roof panel materials are acceptable substrates.

1. **Aluminum-Zinc coated Steel (20-ga., 22-ga., and 24-ga.) (AZ50, AZ 55, AZ60) Galvalume®, Zincalume®** with or without PVDF (Kynar 500, Hylar 5000, Valspar Fluropon) coatings.
2. **Aluminum (32-ga., 40-ga.) with PVDF (Kynar 500, Hylar 5000, Valspar Fluropon) coatings.**

4.2.4 Approved Metal Roof Manufacturers

- ATAS*
- Firestone Building Products

- McElroy Metal*
- Drexel Metal

** Optional – Roof manufacturer factory laminate FLEX to metal roof panels prior to shipping.*

FLEX modules can be installed over a wide range of different metal roof profiles by metal roof manufacturers not listed here. Contractor shall check with the roof manufacturer and verify FLEX is acceptable and will not affect the manufacturer's warranty.

4.3 Orientation and Shading

It is important to avoid full or partial shading from rooftop equipment, structural elements of a building and nearby trees, poles, power lines or other nearby buildings to minimize the impact on the power production of the MiaSolé FLEX series solar array. An on-site analysis using a Solar Pathfinder or other shading analysis tool can provide the solar designer valuable information on the impact of shading on solar power production. MiaSolé recommends a shading analysis to be completed prior to installation.

FLEX modules protect themselves from shade-producing hot spots that may damage other modules, but the electrical performance of any PV module is seriously degraded due to shading obstructions.

4.3.1 Metal Roof Shade Considerations

- Verify metal panel standing seams height will not shade PV modules.
- Set back FLEX modules from mid roof wire management and peak ridge caps to avoid partial shading during the day.
- Do not install J-Box behind Z-Closure.
- Install FLEX modules a minimum of 91.4 cm (3 feet) from standard roof curbs, skylights, gutters and roof penetrations.
- Analyze shade and shadows around higher rooftop units such as HVAC and mechanical equipment before placing the FLEX modules.
- Avoid shading from penthouses and interior building walls, curbs, pipes, WMS, snow guards and parapets.

4.4 Roof Substrate Condition and Installation Preparation

Following the FLEX module and roof system manufacturer's directions for roof surface preparation and installation is critical for FLEX module-to-roof substrate bonding and long-term system performance. Installer's failure to follow manufacturer's recommended roof surface preparation directions and FLEX module installation procedures may void MiaSolé FLEX module and the roof system's warranty.

- FLEX modules with a self-adhesive PVA 600BT backing are designed to bond directly to a metal roof system approved by the roof system manufacturer for direct PV module bonding.
- Deliver metal panel materials and components in manufacturer's original, unopened, undamaged packaging with identification labels intact.
- Store metal roof panel materials on dry, level, firm, and clean surface using factory provide foam supports under the panels. Stack no more than two bundles high. Elevate and ventilate to allow air to circulate and moisture to escape.
- If metal panels are stored onsite, avoid exposing metal panels with protective polymer films from direct exposure to the sun.
- Remove any factory applied protective polymer film from metal panels before panel cleaning and FLEX module installation.
- Metal roof panels with bonded FLEX modules are mechanically attached to the building structure using the same traditional metal panel anchor panel clips and fasteners supplied by the metal roofing panel manufacturer. Use panel clips to allow for thermal expansion of the metal panels and lap seams as required by the metal roof manufacturer.
- Cut and trim metal roof panels prior to cleaning and bonding the FLEX modules.
- Installer should refer to the roof panel plan for exact FLEX module placement on each metal roof panel to align the FLEX module on the metal panel correctly in relation to the ridge cap, ridge trim, middle roof seams and fasteners.
- Metal roof panel surface for FLEX module placement shall be flat and smooth.
- The roofing surface must be cleaned, dry and free of all debris; dust, oil, ice, snow or moisture will inhibit good adhesion and limit the installation lifetime.
- In order to achieve the required adhesion, clean the metal roof surface per the roof system manufacturer's current Technical Specifications where the FLEX modules will be bonded.
- New metal roof panels should be surface cleaned with IPA 2-propanol, isopropyl alcohol diluted with 10% water for no more than 30 minutes prior to bonding of the PVA 600BT adhesive backed part. Use a clean lint-free cloth or disposable lint free wipe for cleaning. Allow the roof to dry completely.

- If new roof panels have been stored outdoors for more than a week, clean the metal panels with water and a mild detergent with a power washer prior to cleaning with IPA 2-propanol, isopropyl alcohol.

4.5 Best Practices for FLEX on Metal Roofing

- Ideally PV modules in each string should have the same solar orientation and solar angle to avoid mismatch and shading issues.
- Installer should perform a solar resource survey on the site (comprising; sun path determination, shade percentage analysis, etc…).
- The FLEX modules are bonded to metal roof panels with a minimum panel width of 406.4 mm (16”) with a vertical standing seam up to 38.1mm (1.5”) high.
- Wider metal panels (45.7 cm, 50.8 cm, and 60.9 cm) (18”, 20”, and 24” respectively) may have a vertical standing seam up to 63.5 mm (2.5”) high depending on the metal panel width to reduce solar shading.
- The metal roof panel must be flat, with no panel stiffener ribs, pencil beading, decorative stripling or embossed textured surfaces commonly used to reduce metal panel oil canning. If your profile contains these, please contact sales@miasole.com for specific roof type application approval.
- Install FLEX modules close to the ridge cap (**Figure 6**), without shading the FLEX module. *Do not place J-Box behind Z-Closure.*
- Do not place FLEX modules across existing metal roof lap seams. On new roofs, plan out panel length and mid roof lap seams to avoid seam coverage by the FLEX modules. Mid roof panel lap seams are typically offset every other roof panel.

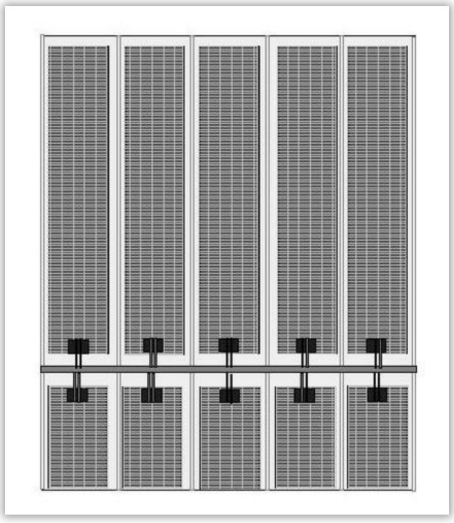


Figure 6. Mid-roof application.

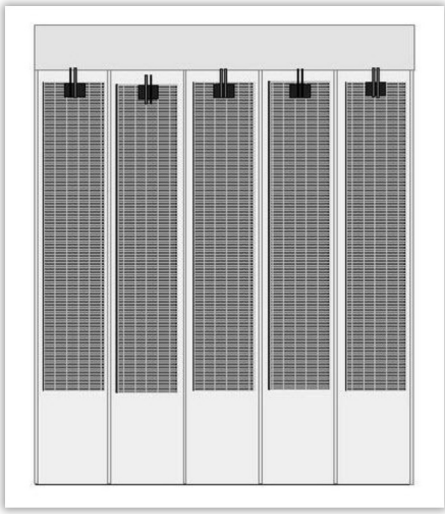


Figure 7. Ridge cap application.

- Installer must provide FLEX module spacing (152.4 mm (6”) minimum) for installation of a wire management system between the ends of two FLEX modules on mid-roof wiring runs, where the J-Box and wire leads are located (**Figure 7**). Space modules far enough apart to avoid solar shading from WMS or snow guards.
- MiaSolé strongly suggests the FLEX modules be checked with a multi-meter for voltage output prior to installing. Ideally modules should be sorted by short-circuit current for best performance in series strings.
- When planning an installation, loading and sequence of work are critical to ensure that equipment and personnel are not required to access work areas by crossing over installed product.

4.6 FLEX Application Instructions – Pre-Integration

The following procedures demonstrate how to bond FLEX modules onto flat metal roof panels prior to installing metal panels onto a new roof structure. The FLEX module should be bonded to the metal roof panel while still on the ground on a flat and rigid work surface. For existing roofs, refer to section 4.7 FLEX Application Instructions – On-Site .

1. Work area must be in a controlled environment (e.g. inside a workshop typesetting) and temperature range must be between 7°C -29°C (45°F-85°F) .
2. Place metal roof panel on a firm work level platform surface *on the ground – not on the roof*. Remove protective film from the metal panel (**Figure 8**).

Figure 8. Removing protective film from metal panel.

3. Clean the metal panel surface (**Figure 9).** Metal panel surface shall be clean and dry before placing the FLEX module.

Figure 9. Cleaning metal panel surface with IPA (Isopropyl Alcohol) using a clean lint-free cloth or disposable lint free wipe.

4. Locate and mark metal roof panel for exact FLEX module placement (**Figure 10**). Refer to roof plan for metal panel and FLEX module location.

Figure 10. Locate module placement – measure & mark.

5. Place FLEX module on the metal roof panel and verify FLEX module fit and alignment.

6. Lift up the FLEX module end (J-Box) about 305 mm (12”) off the metal roof panel surface and peel back the release paper off the FLEX module self-adhesive approximately 152 mm (6”) .

7. Carefully stick FLEX module exposed adhesive surface to metal roof panel surface, being careful to maintain FLEX module’s alignment parallel with metal panel. Lay remainder of FLEX module down.

8. Press top surface of FLEX module to metal panel roof surface to ensure good adhesive bonding. *Note: once more than 102mm – 52mm (4”-6”) of the FLEX module is stuck to the metal roof panel surface do not attempt to remove from the metal panel surface.* Removal of panel may damage the FLEX module and void the FLEX module warranty. Be very careful where starting FLEX module placement and bonding.

Figure 11. Roll and set in place.

9. A second worker from the other end should carefully lift remainder of the FLEX module a few inches off the metal panel roof surface while another worker slowly peels back the remainder of the release liner from the FLEX module adhesive while pressing down the exposed FLEX module adhesive surface onto the metal roof panel surface (refer to **Figure 12**). Avoid tearing release liner. Maintain FLEX module alignment parallel with metal roof panel edge. The worker should

lightly press down in a continuous motion across FLEX module surface width with a clean rubber roller (refer to **Figure 13**) - ensure full module surface contact to metal roof panel surface. Full surface to surface contact will avoid creating voids and air bubbles under the FLEX module and fish mouths along the FLEX module perimeter edge.

Figure 12. One person lifts up module end – other person removes release liner.

10. Once the FLEX module is bonded to the metal roof panel surface, using the rubber roller, reroll the FLEX module with a maximum pressure of 74.5 kg per linear meter (50 lb/linear ft) to ensure full contact with the metal roof panel surface, paying careful attention to FLEX module perimeter edge (**Figure 13**).

Figure 13. Roll module to insure good adhesive contact.

11. Adhere the remaining FLEX modules to the metal roof panel and add a protective layer between the laminated metal panels to protect the modules during shipment /move from the ground to the roof.

12. Install metal roof panel using metal panel manufacturer's approved details.

Figure 14. Metal panel with module on roof & install.

4.7 FLEX Application Instructions – On-Site

The following procedures demonstrate bonding FLEX onto *existing* flat standing seam metal roofs.

1. Ambient temperature range must be between 7°C -29°C (45°F-85°F) .
2. Power wash metal panel surface with water and mild detergent. Then, clean metal panel surface with IPA using a clean lint-free cloth or disposable lint free wipe. Metal panel surface shall be clean and dry before placing the FLEX module on the metal roof panel surface.
3. Locate and mark metal roof panel for exact FLEX module placement Refer to roof plan for metal panel and FLEX module location.
4. Place FLEX module on the metal roof panel and verify FLEX module fit and alignment.
5. Remove release paper off the FLEX module. Avoid tearing release liner. Do not allow exposed adhesive to contact any other surface.
6. From one end, carefully stick FLEX module exposed adhesive surface to metal panel surface, being careful to maintain FLEX module's alignment parallel with metal panel. A second worker from the other end should lay remainder of FLEX module down (maintain FLEX module alignment parallel with metal roof panel edge).
7. Press top surface of FLEX module to metal panel roof surface to ensure good adhesive bonding. *Note: once more than 102mm – 52mm (4"-6") of the FLEX module is stuck to the metal roof panel surface do not attempt to remove from the metal panel surface.* Removal of panel may damage the FLEX module and void the FLEX module warranty. Be very careful where starting FLEX module placement and bonding.
8. Once the FLEX module is bonded to the metal roof panel surface, using a clean rubber roller, roll the FLEX module with a maximum pressure of 74.5 kg per linear meter (50 lb/linear ft) to ensure full contact with the metal roof panel surface, paying careful attention to FLEX module perimeter edge. Full surface to surface contact will avoid creating voids and air bubbles under the FLEX module and fish mouths along the FLEX module perimeter edge.
9. Adhere the remaining FLEX modules to the metal roof panels. Do not step on modules. Do not stand or walk on FLEX modules. Use protective footwear to avoid damaging or scratching modules.

4.8 Connections and Wiring

Each module has two electrical connection wires for making positive and negative electrical connections using MC4 compatible connectors.

- Always use the appropriate MC4 cable removal tools when disconnecting module. Failure to do so will likely result in damage to the cable, connector or module.
- All wiring must meet relevant codes, guidelines, and regulations, and performed by a qualified installer. Please refer to the National Electric Code (NEC) for guidance related to all wiring associated with the photovoltaic system in the U.S.A..
- Wiring must be copper-only with a minimum diameter 1.62 mm (14 AWG), having up to 52 strands, and rated for a minimum of 90°C in accordance with all local codes, guidelines, and regulations. Use conductor wire type rated “PV Wire” or USE-2/RHW-2 at a minimum.
- For installations having a maximum system voltage of 1000V (IEC only), the connectors used must be rated for 1000V.
- Under normal conditions a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions (such as very cold weather or “cloud enhancement”). Accordingly, the values of short-circuit current (Isc) and open-circuit voltage (Voc) marked on this module may be multiplied by a factor of up to 1.25 when determining component voltage ratings, conductor ampacities, fuse sizes, and size of controls connected to the PV output. In the U.S.A., refer to Section 690-8 of the National Electrical Code for an additional multiplying factor of 125% (80% derating) which may be applicable.
- The Voc of the array string must be calculated at the lowest ambient temperature for the location. Use the FLEX module temperature coefficient to calculate the Voc. Ensure that the maximum voltage does not exceed the maximum certified voltage and of other electrical components in the system.

Supplier (Amphenol) Part Number: H4TW0001	 Amphenol Cable Removal Tool
Junction Box Terminations: **Supplier (Amphenol)** **Helios H4 – CONNECTORS**	(+) 

4.8.1 Grounding

- FLEX modules do not have a metallic frame and therefore do not require grounding. Refer to your local authority for any code requirements that may be required in the installation jurisdiction. However, the metal roof panel that the FLEX modules are bonded to should be grounded.
- NEC Section 690.5 requires that systems with FLEX modules on the roof of a building have ground fault protection equipment.
- Grounding of the standing seam metal panels to which the FLEX modules have been bonded can use UL listed grounding clamps. The ground clamp can be fastened to the metal roofing pan seams with a stainless steel machine screw, a star lock washer and nuts.
- Grounding of metal parts, panels and conduit where the FLEX module or PV source wire are passing under or over (in close proximity or otherwise come in contact with), can be accomplished with the use of grounding clamps as described above, or by other listed methods meeting NEC requirements.
- The equipment-grounding conductor needs 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 NEC Table 250-122.
- PV source circuits must be terminated in a terminal box and then run in metal conduit prior to entering buildings. See NEC for further guidance.
- The electrical grounding point for the PV circuit may occur within the static inverter in order to alert the user of a ground fault condition. Refer to the inverter documentation that was provided prior to selecting a ground reference point in the electrical circuit.
- Verify disconnects are suitable for non-grounded conductors. The junction boxes, combiner boxes and disconnects should carry a label “Warning, Electrical Shock Hazard. The DC conductors of this PV system are ungrounded and may be energized” per NEC 690.35 F.

4.8.2 Compatibility with Transformerless Inverters

MiaSole’s high quality FLEX modules do not exhibit any compatibility issues with UL listed transoformerless inverters.

4.8.3 General Wiring Procedures

- The National Electrical Code (NEC) mandates proper PV source circuit wire management. PV source circuits are defined in 690.2 and 690.4. The applicable sections in the NEC regarding PV source circuit wire management include 690.31, 338.10, 334.30, and 110.12. 7.01 General Wiring Procedures.

- Both the National Electrical Code (NEC) and the International Fire Code (IFC) require cables and key solar array components to be labeled. Section 690 of the NEC code outlines the basic parameters for labeling, and the IFC goes a step further by actually defining the size of text, color and physical properties of the label.
- The International Fire Code (IFC) and National Electrical Code (NEC) specifies that Electrical Metallic Tubing (EMT) conduit and raceways must be marked no less than every 3.1 m (10 feet), at every turn, above and below penetrations, and on all exposed raceways, cable trays, and other wiring methods. The labels also must be visible on the covers or enclosures of pull boxes and junction boxes as well as conduit bodies in which any of the available conduit openings are unused.
- Contractor shall place signage at roof access. This signage should clearly state and solar array is on the roof and the dangers associated with a high voltage solar system, the personal protection equipment that should be worn, and emergency telephone numbers for fire and emergency medical service.
- Provide owner with as-built roof plan showing location of roof mount and interior inverters, disconnects and fuse boxes.
- MiaSolé strongly suggests the FLEX modules be checked for voltage output prior to installing.

4.8.4 Wire Management System (WMS)

FLEX solar arrays require a wire management system (WMS) to protect and manage the cable leads between modules and the cable runs back to rooftop combiner boxes or inverters. MiaSolé does not provide or specify a specific brand or type of wire management system. Wire management systems for metal roofs are sourced from third party suppliers or fabricated by the contractor.

- The National Electrical Code (NEC) mandates proper PV source circuit wire management. PV source circuits are defined in 690.2 and 690.4. The applicable sections in the NEC regarding PV source circuit wire management include 690.31, 338.10, 334.30, and 110.12. 7.01 General Wiring Procedures.
- Longer cable runs that exist at the end of source circuits should be periodically secured to avoid wind-related insulation damage. However, such securement must not place stress on the PV module junction box and must allow for seasonal expansion and contraction of the array.

4.8.5 Contractor Fabricated Wire Management –Roof

4.8.5.1 Ridge Caps

Ridge caps on steep slope metal roofs are standard flashing systems and provides a simple wire management chase to run the FLEX module wire conductors and string run for the FLEX modules installed closest to the metal roof peak (see **Figure 15**). Install FLEX module back from the Ridge Cap to avoid shading.

DO NOT INSTALL THE J-BOX BEHIND THE Z-CLOSURE. THIS WILL SHADE THE FLEX MODULE SOLAR ACTIVE AREA AND AFFECT POWER OUTPUT. DO NOT PLACE A FASTENER THROUGH THE FLEX MODULE – THIS WILL VOID THE MODULE WARRANTY.

DRILL A HOLE SIZED THROUGH THE SHEETMETAL Z-CLOSURE TO ALLOW THE CONDUCTOR CABLES INTO THE RIDGE CAP AREA TO BE USED AS A WIRE CHASE. INSTALL A SPLIT RUBBER GROMMET TO THE SHEETMETAL HOLE TO AVOID DAMAGING THE CABLES AND SEAL THE HOLE WITH A CAULK.

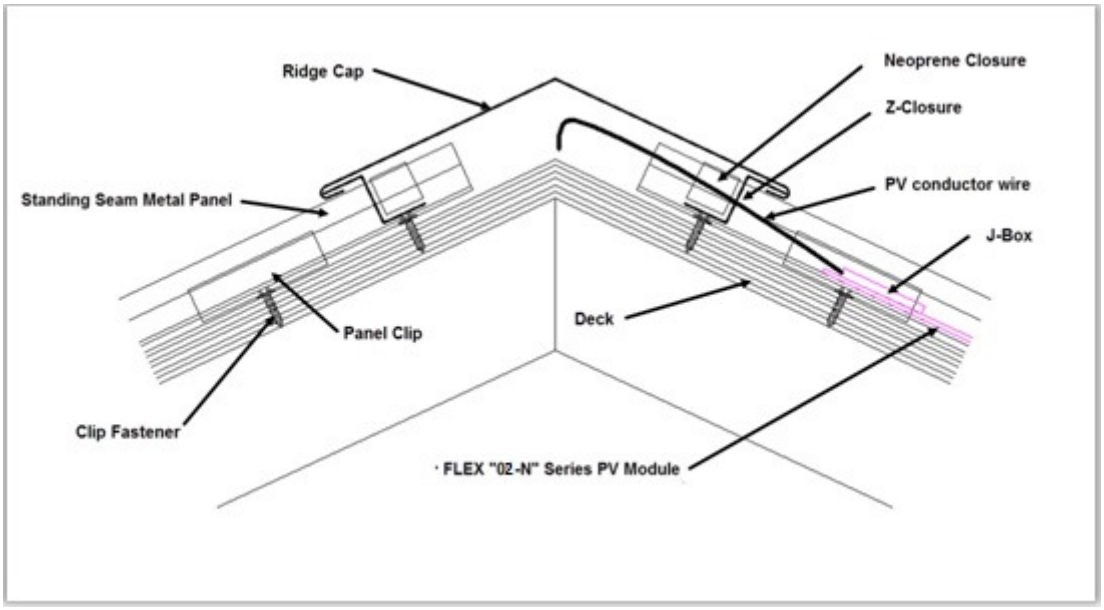


Figure 15. Typical metal roof ridge cap.

4.8.5.2 Mid-Roof Wire Management Tray

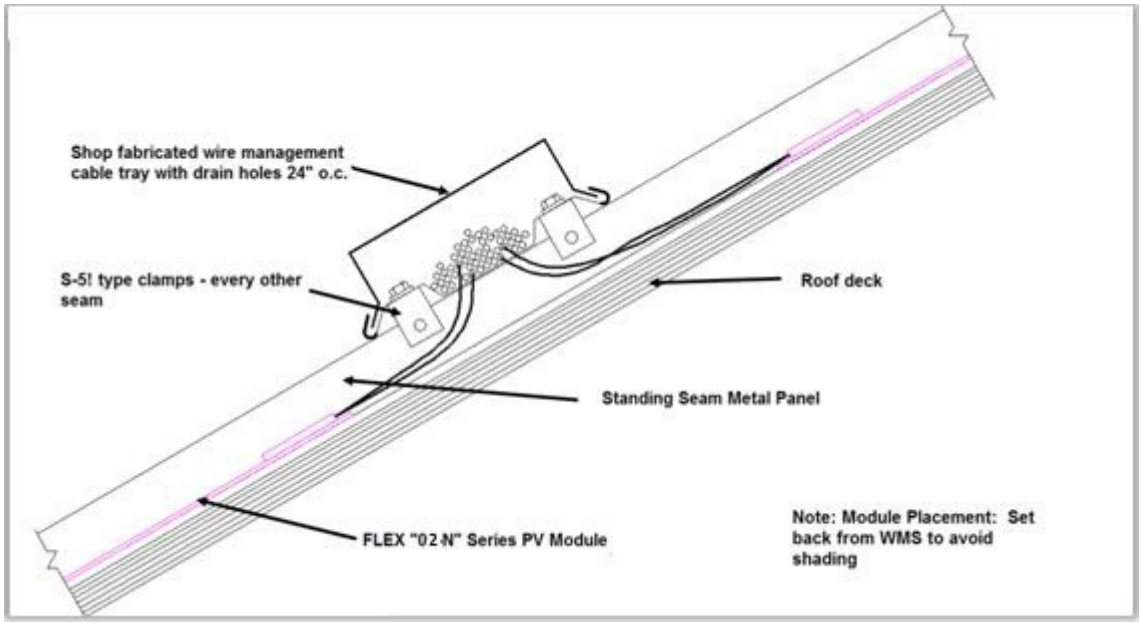


Figure 16. Mid-roof contractor fabricated wire management tray.

- Large roofs with long and multiple metal panel runs will have multiple rows without ridge or eave access. A mounted wire cover tray can be used to conceal the wire string runs. Typically, these are fabricated from the same metal used on the metal roof. On steep roof slopes down to 15° (3/12) full-length contractor fabricated trays and covers can be installed as shown in **Figure 16.**
- In snow-country where excess snow and ice can built up above the mid-roof wire management tray, the WMS tray must be designed and rated for snow retention. Additional snow guards may be required, consult with local code authorities.
- The attachment of the wire management tray to the metal roof system can be completed with standard beam clamps or with blocks made for snow retention and air handling systems such as the “S-5!” mounting blocks.
- Attach beam clamps or S-5! mounting blocks on alternating panels.
- Position FLEX module back from the wire management tray to avoid shading of the FLEX module.

4.8.5.3 Snow Guard Retention System for WMS

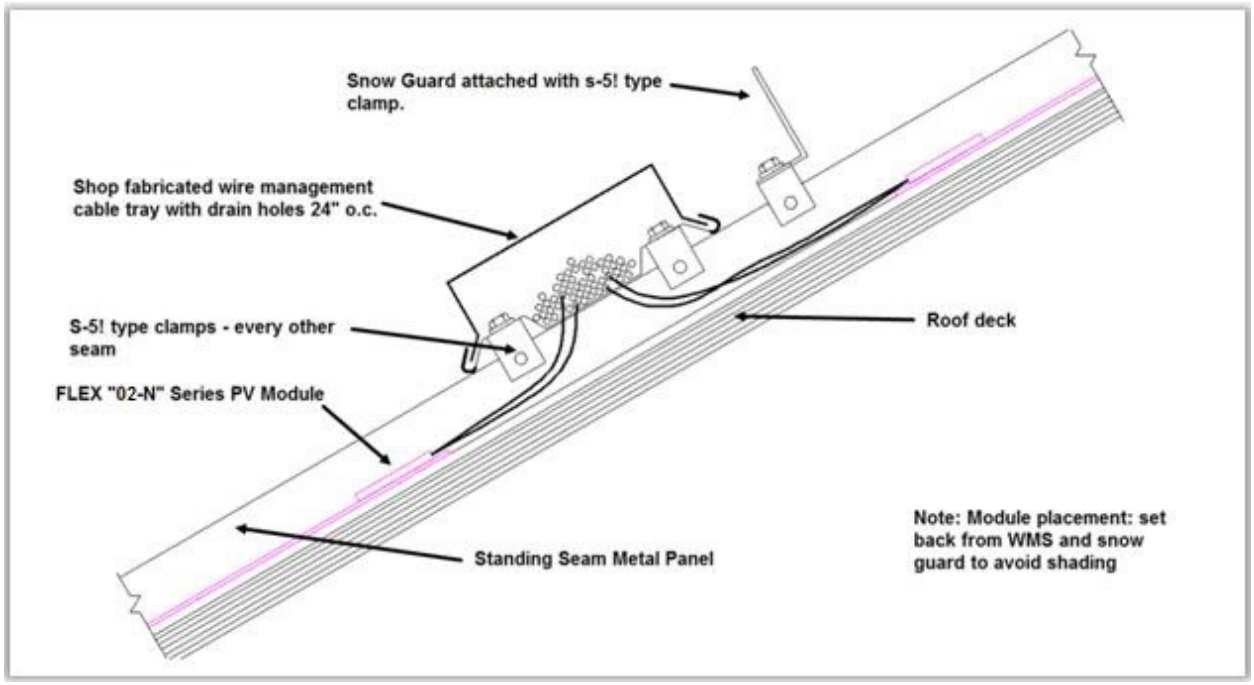


Figure 17. Snow guard & wire management.

- In snow country, protect mid-roof wire management tray with a snow guard retention system to protect WMS tray from snow and ice build-up and sliding snow.
- In snow country, building entrances and walkways areas close to the roof perimeter edge should be protected from falling snow and ice by a system of standard metal roof snow guards as required by local building and safety code.
- In general, rapid snowfall removal from the metal roof and solar modules is encouraged to reduce reduction in solar module power output.

5.0 Contractor and Warranty

5.1 Installation Contractor Responsibilities

- Contractor shall install the FLEX modules on the roof system in accordance with roof system manufacturer's written PV installation specifications and requirements to maintain an existing roof warranty or to meet their requirements for a roof warranty on new roof systems.

- Contractor, before installing modules, shall contact the appropriate local jurisdiction to obtain any required building permits and to determine any installation and inspection requirements that apply to the installation site. This includes any local jurisdiction requirements relative to applicable codes.

- Contractor shall determine if the construction or structure (roof, facade, support, etc.) where the FLEX modules are being installed can physically support the installation.

- Following roofing, electrical, and construction safety practices will assure the installation will be carried out without injury or incident. Take special precautions if there is precipitation or high wind present at the site.

5.2 Pre-Project Information Form and Warranty Submittal

- **MiaSolé requires the MiaSolé Project Notification Form (PNF) to be completed and submitted to MiaSolé Technical Department along with the roof plan showing the FLEX modules and balance of system components design and locations for review prior to shipping the FLEX modules for the project.**

- Contractor shall provide scaled roof plans showing all location, layout and dimensions of metal roof panels on roof structure, mid roof panel seam location, perimeter roof details, gutters, skylights, hatches, HVAC and mechanical equipment, penthouses, pipes, stacks and conduit runs and show exact placement of FLEX module layout on the roof. FLEX modules should be grouped together based on string sizing, DC combiner location, and PV wire runs.

- Roof plans shall:
    - Identify and number all PV string runs.
    - Show roof slope.
    - Show roof top and interior building location of all balance-of-system components, including home runs, disconnects, fuse boxes, combiner boxes and inverters.

- MiaSolé' recommends a structural engineer or architect should be used to determine project requirements of material finish, metal panel gauge, metal panel profile and metal panel

attachment methods based on the expected wind loads and meeting local building code requirements at the project site.

- Contractor shall have written prior approval from the roof system manufacturer for the installation of the MiaSolé FLEX-02N or FLEX-02NS series modules over the approved roof system.
    - On new roofs, Contractor shall comply in advance with roof system manufacturer's requirements for BIPV installations for a warranted roof system.
    - On existing roofs, Contractor shall comply with roof system manufacturer's requirements for BIPV installations over exiting roofs for a warranted roof system.
    - Contractor shall comply with all local code requirements to obtain a permit for the project.
- MiaSolé Technical Department shall review the submitted documents, provide technical feedback and assign the project a MiaSolé Project Tracking Number and will returned an approved copy of the submitted form to the Contractor.

5.2.1 Warranty Submittal Information

- Upon completion of the project, Contractor shall submit a completed "Request for Warranty" (RFW) and a copy of the As-built Roof Plan to MiaSolé technical Department. Once MiaSolé has reviewed RFW and as-built roof plan, if the PV installation meets MiaSolé requirements for a warranty, a project warranty will be issued.
- MiaSolé may require a project inspection of the Contractor's FLEX installation by MiaSolé technical staff prior to issuing a project warranty.

6.0 Maintenance and Cleaning

Keeping the FLEX modules clean and unsoiled is critical to achieve maximum power production and for improving the return on investment (ROI) for the system. While rain will clean off dust and light soiling, it is critical to inspect and clean the FLEX modules at least twice a year. In high soiling areas such as the desert, urban, or in rural agriculture, the FLEX modules may require more frequent cleaning.

- Observe all roof top safety and OSHA rules.
- Disconnect the utility and/or battery sources and isolate the output of the modules.
- Use caution when cleaning FLEX modules, as the combination of water and electricity may present a shock hazard.
- Be cautious - roof and FLEX modules are extremely slippery when wet.
- Wear slip-resistant soft rubber sole shoes and protective gloves when cleaning FLEX modules.

- Visual inspect solar array for damaged wires, loose connections and damaged FLEX modules before cleaning.
- When cleaning FLEX modules; use a clean, damp, soft, non-abrasive micro-fiber cloth or sponge to wipe soil off modules. Wipe with a gentle motion, and do not use excessive down force.
- Do not use solvents or acetone for cleaning.
- Do not use brushes, power cleaners, or power scrubber on FLEX modules.
- Do not direct water spray at FLEX module J-Boxes and conduit connections. High-pressure water spray should never be used as it may damage the module and void the warranty.

7.0 Appendix

7.1 Rooftop Safety Warnings

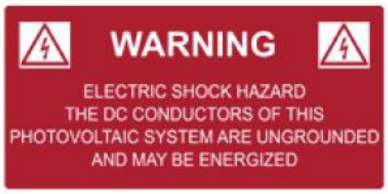
Roofs are challenging workplaces requiring complete awareness of the roof top environment when working. Personnel should exercise extreme care and caution on the roof at all times to avoid injury or death.

- All work shall be performed in accordance with the requirements of the, Occupational Safety and Health Administration (OSHA) requirements, and other agencies regulating the safety and proper workmanship of this job.
- Use caution accessing the roof using ladders.
- Ladder being used must be rated to carry the combined weight of the user and the material being installed. Type IA and Type I ladders are the only acceptable ladders on a construction jobsite.
- Ladders shall be tied off and extended a minimum 0.9 meters (3 feet) above the roof surface edge.
- Workers shall be aware of the roof perimeter. Anyone working at heights of six feet or more above another surface in construction needs to be protected by guardrails, safety nets, or personal fall protection systems. These regulations also apply to skylights and other roof openings.
- Pay attention to any posted safety signage at roof access point. Provide clear warning signage at each access point to the installation. This signage should clearly state the dangers associated with a high-voltage solar system, the personal protection equipment that should be worn, and emergency telephone numbers for fire and emergency medical service.
- Wear all appropriate personal safety equipment while working on the roof with the FLEX modules including fall restraint system, hardhat, proper footwear, safety glasses, and gloves.
- Workers shall not be involved in construction, repair, or maintenance operations on roofs during periods of high winds (such as when a wind advisory has been issued), lightning storms, snowstorms, or other potentially hazardous weather conditions.
- Be aware and careful of conduit runs and other trip hazards on roof. Personal injury can result from tripping over power cords, tools, electrical conduit, natural gas lines, and/or installation materials

7.2 Labeling

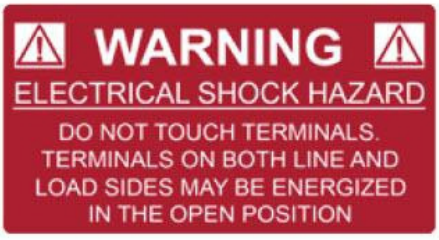
- Both the National Electrical Code (NEC) and the International Fire Code (IFC) require cables and key solar array components to be labeled. Section 690 of the NEC code outlines the basic parameters for labeling, and the IFC goes a step further by actually defining the size of text, color and physical properties of the label.
- The International Fire Code (IFC) and National Electrical Code (NEC) specifies that Electrical Metallic Tubing (EMT) conduit and raceways must be marked no less than every 10 feet, at every turn, above and below penetrations, and on all exposed raceways, cable trays, and other wiring methods. The labels also must be visible on the covers or enclosures of pull boxes and junction boxes as well as conduit bodies in which any of the available conduit openings are unused.
- Contractor shall place signage at roof access. This signage should clearly state a solar array is on the roof and the dangers associated with a high voltage solar system, the personal protection equipment that should be worn, and emergency telephone numbers for fire and emergency medical service.
- Provide building owner with a roof plan showing location of roof mount and interior inverters, disconnects and fuse boxes.
- In addition, in **NEC690.4 (F)**, the installer must clearly mark circuits that are hidden under build up, PV module or other membrane roofing materials that are not covered by FLEX modules. The label is to be printed with the following text: PHOTOVOLTAIC POWER SOURCE.

- **NEC690.35 (F)** A PV power source shall be labeled at each junction box, combiner box or disconnect, and device where energized circuits may be exposed during service.



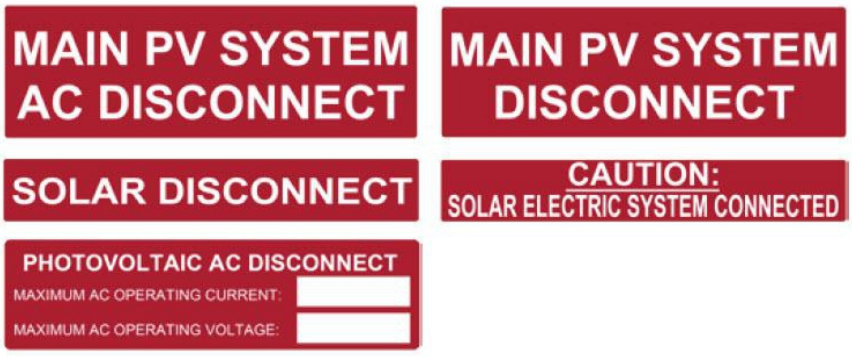
- **NEC690.5(C)** A label shall appear on the utility interactive inverter or be applied by the installer near the ground fault indicator at a visible location. This is typically only used on ungrounded systems.

- **NEC690.17** Where all terminals of the disconnecting means may be energized in the open position; a warning label shall be mounted on adjacent to the disconnecting means. For use on AC/DC disconnects, junction boxes or breaker panel.



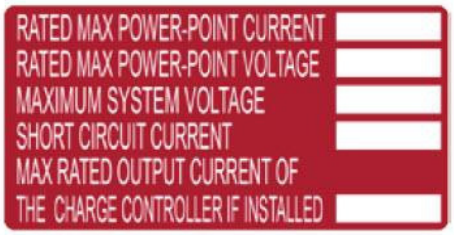
- **NEC110.27(C**) or **OSHA 1910.145(f) (7**) Warning labels are used to represent a hazard. For use on the breaker panel, main disconnect as well as junction and combiner boxes.

- **NEC690.14 (2) and NEC690.1(C) (2)**



- **NEC690.15** If equipment is energized from more than one source, the disconnecting means must be grouped and identified.

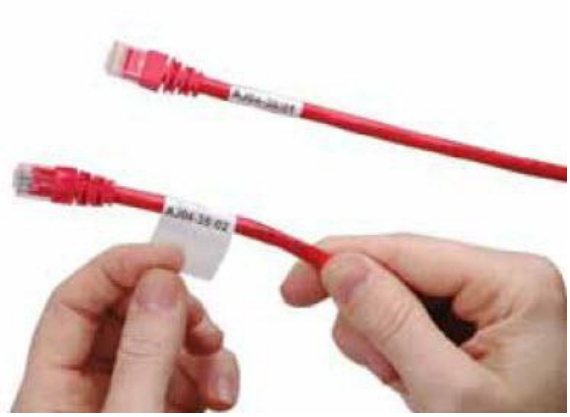
- **NEC690.53 (D)**



- **NEC690.16 (B)** Non-load-break-rated disconnect mean shall be marked “Do Not Open Under Load.”

- **NEC690.33 (E) (2)** Interruption current – be a type that requires the use of a tool to open will be marked “Do Not Disconnect Under Load.”

- **NEC690.4** Where conductors of more than one PV system occupy the same junction box, raceway or equipment, the conductors of each system shall be identified at all terminations and splice points. Cables can be marked using UL969 approved self-laminating vinyl labels.



Refer to Cal Fire Solar Photovoltaic Application guideline for additional label and sign guidance.

http://www.fsec.ucf.edu/en/education/southeast_training_network/Background%20on%20CA%20PV%20Installation%20Guide.pdf

7.3 Pre-Inspection and Commissioning Audit

Performing a visual audit of the solar array at the completion of installation is important, as this will provide a good baseline for future operation and maintenance visits.

- Do a visual inspection of the complete array.
- Verify all electrical connections.
- Ensure that appropriate safety signs are in place at each access point to the installation.
- Record the serial number of each FLEX module, it's location on the roof, and to which combiner box and inverter each PV module is connected on the "as built plans".
- Check that each FLEX module is fully bonded to the substrate. If any areas of the FLEX module are NOT fully bonded, mark the roof by non-bonded PV module with a permanent marker or crayon to flag the area to be repaired.
- Check the front surface of the FLEX module for any scratches or surface damage that may have occurred during installation. If there is damage, the panel may need to be replaced.
- Clean any FLEX modules that are particularly dirty before performing electrical checks. Excessive dirt, debris, or film on the FLEX modules will limit performance and create false test results.
- Verify that all FLEX modules are located in areas that have minimal shading.
- Verify that all FLEX modules are located in areas that are not subject to water ponding.
- Verify that the cables are appropriate for outdoor use, fit properly in a cable duct, and are NOT in standing water.

- Inspect cables to verify that the connections are tight and cables are not frayed.
- If the DC system is floating (not earthed or grounded), then fuses should be connected in both the positive and negative poles.
- For systems that require grounding, verify that there is continuity between all metallic substrates and that the ground connection is correct.
- Fill in the warranty registration form, attach a list of FLEX module serial numbers, and submit with the MiaSolé warranty form to MiaSolé.
- Ensure that the drainage system is unblocked.

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This MiaSolé installation guide is for use by an experienced roofing - solar contractor. The guide is intended to be used only in coordination with all building, electrical, fire and other codes or regulations applicable at the site where a system using the MiaSolé Flex Series PV modules are installed. All applicable local, state, and national codes take precedence if there is any discrepancy between this manual and applicable local, state, and national codes.