



# **TESLA SOLAR PANEL**

## **INSTALLATION MANUAL**





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## NOTICES

- Initial publication.

This manual contains safety, installation, configuration and troubleshooting instructions for Tesla Solar products. Tesla recommends that you save this manual in a readily accessible location should any questions arise.

Tesla Solar Panels are designed for use with UL 2703 listed mounting systems including [Tesla Panel Mount - Comp Rafter](#), [Tesla Panel Mount - Tile](#), Tesla Panel Mount - Metal, Tesla Panel Mount - Flat, and Zep solutions including [ZS Comp](#), [ZS Span](#), [ZS Seam](#), and [ZS Ramp](#).

Tesla Solar Panels are designed for a maximum altitude of 3000 m above sea level.

Artificially concentrated sunlight shall not be directed on Tesla Solar Panels.

The recommended mount height is 80 mm.

Install Tesla Solar Panels at a minimum angle of 3°.

It is recommended that Tesla Solar Panels be installed in an environment with ambient temperature ranging from -40 °C to +40 °C. The 98th percentile of the module operational temperature should be of 70 °C or lower under any mounting conditions.

Connection of Tesla Solar Panels in series is only permitted up to the maximum system voltage as listed in the applicable datasheet, accounting for operating conditions, safety margins, and the voltage limit of the inverter. A maximum of two strings of Tesla Solar Panels may be operated in parallel on a single inverter or MPP tracker.

This system should be periodically re-inspected by qualified service technicians. In the event any components or fasteners are found to be loose, they should be re-tightened to the manufacturer's specifications. Any components showing signs of corrosion that compromise safety or function shall be replaced immediately.

All Tesla Groove compatible modules comply with IEC/UL 61730 and have been evaluated for grounding and mounting in compliance with the included instructions.

To communicate feedback about this document, please reach out to your Tesla Representative.



## IMPORTANT SAFETY INSTRUCTIONS



**WARNING:** Read and understand all instructions before you install, wire, operate, or maintain a PV system. Failure to read and comply with any of the limitations noted herein can result in property damage, serious bodily injury, or death. The installer assumes the risk of all injury that might occur during installation, including, without limitation, the risk of electric shock.

- Always use qualified personnel for installation.
- Always follow PV module manufacturer safety precautions, installation instructions, and operating guidelines.
- Always abide by local, regional, and national statutory regulations when installing the system, and obtain a building permit when required.
- Always use equipment, connectors, and wiring suitable for solar electric systems.
- Always use fall protection when working from heights of 6 feet (183 cm) or above. Follow Occupational Safety and Health Act (OSHA) or local governing safety regulations regarding fall protection.
- Always use insulated tools that are approved for working on electrical installations.
- Always wear suitable personal protective equipment (PPE) to prevent the risk of personal injury, such as fall hazards or electrical hazards.
- Always exercise caution when transporting and installing PV modules.
- Do not walk on the PV modules.
- Always wear non-slip gloves when carrying PV modules.
- DO NOT wear metallic rings, watchbands, earrings, facial jewelry or piercings, or other metallic objects while installing or troubleshooting PV systems.
- DO NOT contact or touch electrically-charged, accessible live parts of PV modules, such as terminals.
- DO NOT touch the PV module unnecessarily during installation.
- DO NOT attempt to make an electrical connection with wet, soiled, or otherwise faulty connectors.
- DO NOT use a PV module with broken glass or torn backsheet.
- DO NOT open electrical connections or unplug connectors while the circuit is under load.
- DO NOT allow children or unauthorized persons near the installation.



# RESIDENTIAL SAFETY PROCEDURES

## About Residential Safety Procedures

These Residential Safety Procedures provide residential Electrically Qualified Persons with consistent methods for performing tasks safely. All Residential Safety Procedures were reviewed and approved by EHS and SMEs after working with Process Engineers to define the safest methods of conducting work.

The procedures in this section address common residential safety activities, including electrical hazards, personal protective equipment (PPE), energy isolation and verification, equipment access, and other task-specific precautions.

## Using Energy Library

These procedures are just a few that are found in the **Energy Library**. Energy Library is the central hub for Tesla Energy product docs and resources used by installers and field technicians.

[Check out the Energy Library Introduction video](#) to learn more about Energy Library and finding the content you need.

## Put on Full Residential PPE

### Overview

The following PPE is required when there's a risk of arc flash and electrical shock:

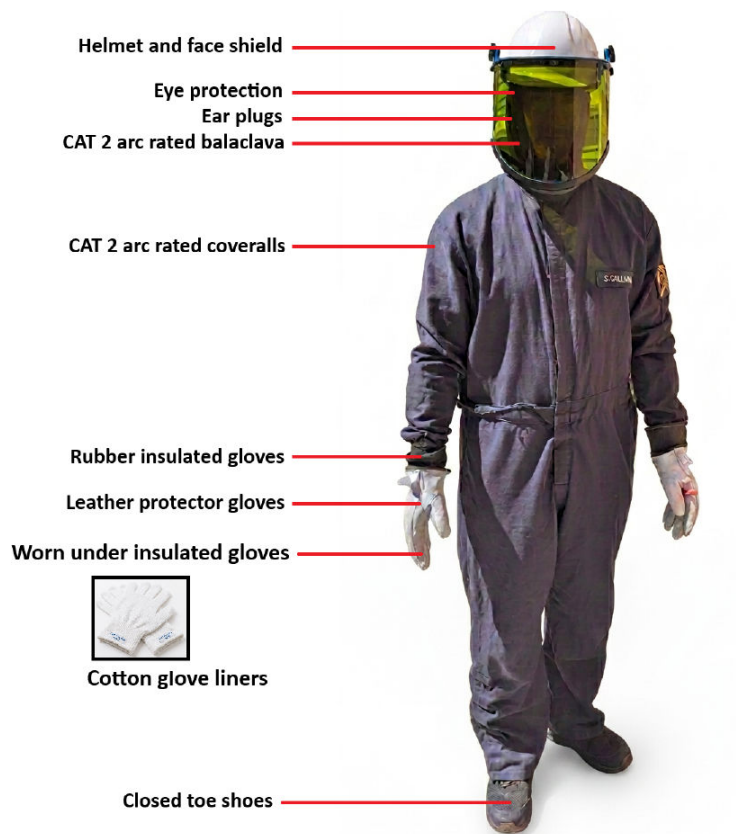


# RESIDENTIAL SAFETY PROCEDURES

## Residential Arc Flash and Shock PPE

All equipment must be CAT 2 (8 cal/cm<sup>2</sup>).

Always wear the following when exposed to a live electrical circuit.



**The above PPE is the minimum required for your safety. Make sure the PPE you wear provides protection for all identified hazards.**

Do not wear clothing, headwear, personal items, or accessories that interfere with the fit, coverage, seal, or protective function of required PPE. Always remember to wear non-melting layers beneath arc-rated PPE. Do not wear underwear, undershirts, base layers, or other garments made from meltable materials, such as polyester, nylon, polypropylene, or spandex, unless the garment is specifically arc rated or permitted as part of the approved PPE system.

## Prerequisites

- Technician understands the applicable electrical hazards and PPE requirements.
- All arc-rated clothing worn to work is clean, undamaged, and worn over non-melting base layers.
- Arc-rated and/or fire-rated garments are not torn, heavily soiled with flammables (like oil, grease, or solvents) or have missing closures.
- All arc-rated and/or flame-resistant garments worn to work must be laundered following the manufacturer's care label or washed in warm or cold water with a mild detergent separately from regular clothing, without fabric softeners. Clothing may be hung to dry, or tumble dried on low/medium heat without dryer sheets. Dry cleaning is only acceptable when stated on the manufacturer's care label.



# RESIDENTIAL SAFETY PROCEDURES

## Safety and PPE

- CAT 2 arc-rated long-sleeve shirt (tucked in) and pants, or arc-rated coveralls ( $\geq 8 \text{ cal/cm}^2$ , IEC 61482-2 Class 2)
- Ear plugs / ear canal inserts (ANSI S3.19 / EN 352-2)
- CAT 2 arc-rated balaclava ( $\geq 8 \text{ cal/cm}^2$ )
- Safety glasses with side shields (ANSI/ISEA Z87.1 or EN ISO 16321 or EN 166), non-conductive frames
- Class E hard hat (ANSI Z89.1 / EN 50365) and CAT 2 arc-rated face shield ( $\geq 8 \text{ cal/cm}^2$ )
- Closed-toed shoes (ASTM F2413 or EN ISO 20345/20347)
- Class 0 insulating electrical gloves with leather protectors, or equivalent protectors (ANSI/ISEA 105 cut A4, abrasion A3, ASTM CAT 2)
- Lockout/Tagout kit (locks, tags, hasps, lock box)
- Cotton glove liners (worn under insulated electrical gloves)

## Donning PPE

1. Make sure to review Prerequisites for requirements for arc-rated and fire-resistant clothing and undergarments before beginning. If any garment does not meet the requirements, do not wear.
2. Remove jewelry, watches, keys, lanyards, and other conductive or loose items that could contact energized parts, fall into electrical equipment, or interfere with required PPE. Secure long hair and loose clothing.
3. Inspect all PPE. Refer to [Inspecting PPE on page 6](#).
4. **Put on the PPE and verify proper fit, coverage, and compatibility with all other required PPE.** First, put on CAT 2 coveralls (or arc-rated, long-sleeved shirt tucked in to arc-rated pants), then eye protection and ear protection. Next, put on AR balaclava, then hard hat with face shield. Finally, put on rubber gloves, with leather protector gloves last.  
**Never use damaged, contaminated, or improperly fitting arc-rated PPE.**

## Inspecting PPE

Follow these steps before putting on PPE.

1. Wear sturdy, closed-toe work footwear appropriate for the identified hazards. Where an arc flash or shock assessment specifies additional footwear protection, wear the required protective footwear. Inspect footwear for damaged soles, loss of tread, sole separation, holes, exposed protective components, damaged closures, significant contamination, or other damage that could compromise its protective function or create a slip/trip hazard. Replace shoes when they show signs of wear.
2. Check arc-rated and fire-resistant clothing for holes, fraying, broken snaps/zippers, thin spots, burns, or chemical stains. Remove items from service that are contaminated with oil, grease, or flammables. If garments are damaged or past service life, tag them out and replace; do not repair with non-FR thread or materials.
3. Perform a visual inspection of the insulated gloves. Remove the leather protectors. Inspect the entire surface of the insulated gloves, inside and outside. Make sure there are no cuts, cracks, holes, snags, embedded metal, chemical swelling, ozone checking, thin spots, burns, or sticky/soft rubber.
4. Conduct an air test of the insulated gloves, one at a time: Hold the glove pointing down; roll the cuff toward the fingers to trap air. Squeeze and listen/feel for leaks. Hold near face/ear or cheek to detect escaping air. Inspect the inflated glove again for weak spots or pinholes. Repeat for the other glove. If any issues are found, remove the gloves from service and replace the gloves.



# RESIDENTIAL SAFETY PROCEDURES



**NOTE:** Rubber insulating gloves must have a current electrical test and be retested at least every six months after being issued for service. Remove gloves from service if they fail inspection or testing, or if their insulating integrity is questionable.

5. Inspect leather protector gloves, looking for cuts, holes, embedded metal, or heavy grease. Make sure the stitching is in good condition. If flaws are found, tag the gloves out and replace them. Do NOT use tape or other adhesives to repair leather protectors used for electrical work.
6. Inspect hearing protection for damage, deterioration, contamination, and proper fit. For reusable earplugs, inspect for cracks, tears, hardening, or deformation. Do not use hearing protection that is damaged or cannot achieve a proper fit or seal.
7. Inspect eye protection. Check lenses for cracks, chips, deep scratches, cloudiness, or other damage that could impair vision or protection. Check frames, temples, side shields, straps, and seals, as applicable, for damage or deterioration. Verify the eye protection is clean, fits securely, and does not interfere with other required PPE. Do not use damaged eye protection.
8. Check hard hat and face shield, attachment hardware, closures, and adjustment components for damage and proper operation. On the hard hat, inspect suspension, shell cracks, and date/service life.
9. Inspect the AR balaclava for holes, tears, burns, damaged seams, contamination, or other deterioration. Verify the required arc rating is legible and inspect the shield or lens for cracks, deep scratches, warping, heat damage, contamination, or impaired visibility.

## Residential Panel LOTOV

### Overview

Before performing work on energized systems, follow the instructions in this procedure to perform Lockout/Tagout and Verify (LOTOV).

**WARNING:** For de-energized panel work, do not assume load-side conductors or components are de-energized. Treat all exposed electrical parts as energized until absence of voltage has been verified using the required Live-Dead-Live test.

### Prerequisites

- Only trained and authorized personnel are permitted to perform this procedure.

### Hazards

Figure 1. Shock



Figure 2. Arc Flash





# RESIDENTIAL SAFETY PROCEDURES

## Safety and PPE

- Insulated multimeter (Fluke 1587 FC or equivalent; rated for equipment voltage)
- Lockout/Tagout kit (locks, tags, hasps, lock box)
- Insulated guarding mat

## LOTOV

1. Stage the work area. Identify the main service panel and dead front, and remove any obstacles that block egress. Identify the primary exit path.
2. Visually inspect the main service panel and dead front. **If there are any active hazards (such as arcing, heat, odor, or water on live equipment) STOP work immediately and notify your supervisor.**
3. Place insulated guarding mat directly under the area where work will be conducted.



**NOTE:** Keep unqualified persons out of the work area when it's not electrically safe.

4. Put on PPE. See [Put on Full Residential PPE on page 4.](#)
5. If the main disconnect must remain live (for example, during testing, commissioning, or restoration), leave breakers switched in their current position and skip to step 8 to check for dead. If de-energization of the main disconnect is required, power down any generation sources that may back feed the panel. For Tesla equipment, turn off the product switch and stop the system in the Tesla app. For third-party equipment, follow the manufacturer's instructions to shut down the unit. Turn off all breakers.  
For energized panel work, expect 240V to be present on load-side bus bars and conductors.



## RESIDENTIAL SAFETY PROCEDURES

### 6. Apply Lockout/Tagout (LOTO).



7. Inspect the leads, probes, and fuse of an insulated multimeter. Set to measure AC. Using an AC live source or proving unit, ensure the multimeter is operational and reads the correct value. If multimeter gives incorrect readings do not continue, substitute the meter for another one and repeat the check. Only move forward if the multimeter is functioning correctly.
8. Using insulated probes, measure on the load-side of the isolation point(s). Verify voltage is 0 V AC at each test point:
  - Each ungrounded conductor or exposed bus section to neutral (L1–N, L2–N)
  - Each ungrounded conductor to equipment ground (L1–G, L2–G)
  - Phase-to-phase (L1–L2)
  - Neutral to ground (N–G)



**WARNING:** Touching bus bars or lugs is strictly prohibited until this step is complete. Do NOT remove any insulation guards on the line-side.

9. Where generation exists (such as a PV system, a battery, or a generator), verify that each source path which could back-feed the panel shows 0 V.
10. If no unexpected voltage is detected, continue. If any residual or unexpected voltage is present, **STOP**. Do not proceed with next steps. If it's safe to do so, re-verify isolation, sources, and metering. Otherwise, escalate to your supervisor.
11. If the main breaker is isolated in its own enclosure and locked out (as shown in the image below), and you're working downstream on other equipment, it's safe to remove PPE. If there are energized conductors or insufficient guarding in the panel, continue wearing full PPE.

Examples of insufficient guarding include:

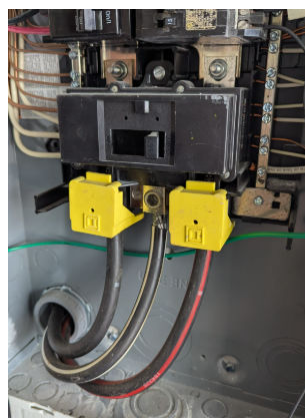
- Exposed wire threads (bare conductor strands showing)
- Exposed lugs or screws on utility feeds (open terminals on the supply side)
- Guarding that a wire or tool could accidentally touch (such as covers with gaps, missing barriers, or parts that could accidentally touch a tool)
- Field-installed guarding (for example, yellow insulated blankets are insufficient)



## RESIDENTIAL SAFETY PROCEDURES



**NOTE:** Lug barriers/covers are not reliable for preventing accidental contact or arc-initiation. If unsure whether the existing guarding provides adequate protection, stop work and contact your supervisor for guidance.



12. Continue with the remaining steps in the work order.

### Remove a Dead Front

#### Overview

Follow these instructions to safely remove a dead front. After removing the dead front, do not use any material or object as a temporary cover. Only the dead front is permitted to cover the energized components.



# RESIDENTIAL SAFETY PROCEDURES

**WARNING:** Removing the dead front exposes energized bus bars and lugs. Keep hands, tools, and the dead front clear of energized components during removal to prevent electric shock or arc flash.

## Prerequisites

- Only trained and authorized personnel are permitted to perform this procedure.
- The technician must confirm that line-side conductors and terminals remain energized and identify all locations that may remain energized after the dead front is removed.

## Hazards

Figure 3. Shock



Figure 4. Arc Flash



## Safety and PPE

- Insulated guarding mat

## Dead Front - Remove

1. Stage the work area. Identify the main service panel and dead front, and remove any obstacles that block egress. Identify the primary exit path.
2. Visually inspect the main service panel and dead front. **If there are any active hazards (such as arcing, heat, odor, or water on live equipment) STOP work immediately and notify your supervisor.**
3. Place insulated guarding mat directly under the area where work will be conducted.



**NOTE:** Keep unqualified persons out of the work area when it's not electrically safe.

4. Make sure the hand tools you need are available. Do NOT use power tools for this procedure.
5. Put on PPE. See [Put on Full Residential PPE on page 4](#). PPE must be kept on for the duration of this task.

6. **WARNING:** Do not apply excessive force to a seized screw. The tool could slip and contact the bus, resulting in an electrical arc or other electrical hazard. If a screw is seized or does not turn, stop work and escalate before proceeding. Keep dead front metal edges clear of bus and lugs.



## RESIDENTIAL SAFETY PROCEDURES

Loosen dead-front fasteners, starting with the most easily accessible screws. Support the cover so it doesn't fall or swing into live parts. Place removed screws into a parts tray.



**NOTE:** For hinged or interlocking covers, follow manufacturer release sequence. Never pry against bus barriers.



7. Support the dead front before removing the final screw to prevent it from shifting unexpectedly.
8. After removing the last cover screw, grip the edges of the dead front and pull it straight off the engagement tabs. Do not tilt or rotate the dead front toward the bus bars or main lugs.



**WARNING:** The dead front can contact energized bus bars or lugs during removal, causing an arc flash or electric shock. Keep the dead front clear of energized components and remove it straight outward without tilting or rotating it.



# RESIDENTIAL SAFETY PROCEDURES



9. Move the cover to a safe location away from the work zone on a clean dry surface or lean it against a wall in a dry area.
10. Continue with work as directed.



**WARNING:** Reinstall the dead front to cover the energized components if you need to step away from the panel. Do not use a temporary or substitute cover after removing the dead front.

## Replace a Dead Front

### Overview

This procedure includes steps to safely replace a dead front.



**CAUTION:** Use hand tools only when installing dead-front screws. Do not use power tools. Loss of tool control can result in contact with energized components and cause electric shock or arc flash.

### Prerequisites

- Only trained and authorized personnel are permitted to perform this procedure.

### Hazards

Figure 5. Shock





# RESIDENTIAL SAFETY PROCEDURES

Figure 6. Arc Flash



## Safety and PPE

- Insulating guarding mat

## Dead Front - Replace

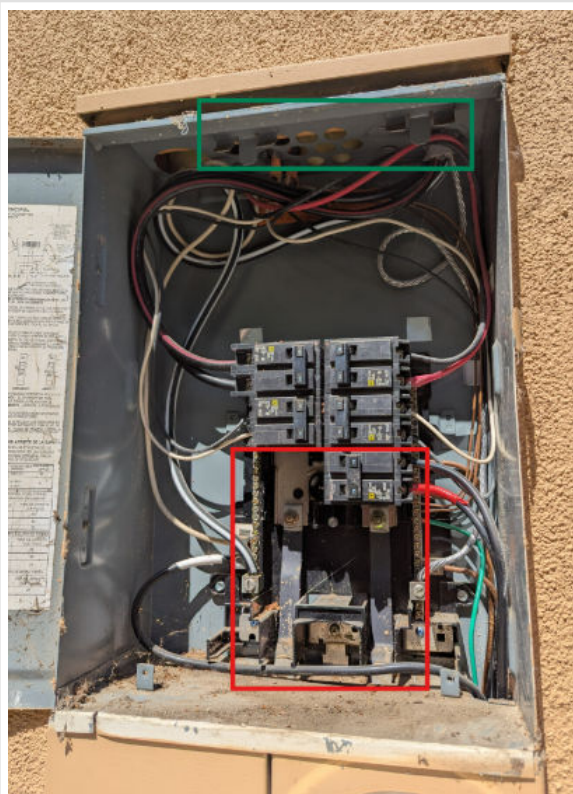
1. If the dead front hasn't yet been removed, follow the instructions in [Remove a Dead Front on page 10](#). If the dead front has been removed, continue with the next step.
2. Confirm that no foreign objects, tools, or fasteners remain in the enclosure or on the bus bars. Confirm that breakers are fully seated.
3. Visually confirm gutters are clear and conductors are not pinched on cover landing surfaces. Ensure there are no wires or bus bars behind the cover screw's threaded hole. Any contact with live wiring can cause arcing once power is restored. If any damage to wiring is observed, STOP work and contact your supervisor.





## RESIDENTIAL SAFETY PROCEDURES

- Retrieve the original dead front cover. Align the slots/tabs with engagement tabs/hooks (see green box in image below). Angle dead front cover AWAY from bus bars and lugs to avoid touching bus bars (see red square below) or live wires to avoid arcing. Ensure breaker handles align with dead-front openings. For flush-mount panels, ensure cover sits true to wall trim without binding. Do NOT force a cover over misaligned handles.



- While supporting the cover, start replacing all original screws by hand or with a hand tool but do not fully tighten one corner first. Do not substitute longer screws that could penetrate bus or wiring.



**NOTE:** If a screw hole is stripped, stop and use manufacturer-approved repair method; do not leave cover loose.



## RESIDENTIAL SAFETY PROCEDURES

6. Tighten screws in a cross pattern until the cover is flush and stable. Do not overtighten the screws. Overtightening can strip or damage the sheet-metal screw holes. Refer to torque guidance on the main service panel if available.



7. Verify that there aren't any gaps that could allow access to live parts. Verify that all breaker handles operate freely through openings.
8. Confirm that the directory/schedule is still affixed, legible, and accurate. Replace if damaged.



9. If de-energized panel work was conducted, prepare to restore power. Switch on all breakers. Power on any generation sources that were previously turned off.
10. For any additional power sources, follow the manufacturers' instructions to turn on.
11. Confirm proper operation is restored. After confirming that all covers are in place, PPE may be removed.
12. Remove insulated mat and tools; restore area and remove any debris.
13. Let the customer know that work is complete.

## Remove an AC Breaker



# RESIDENTIAL SAFETY PROCEDURES

## Overview

This procedure contains steps for removing an AC breaker from a residential panel.

## Prerequisites

- Determine whether the panel will be placed in an electrically safe work condition/LOTOV or whether energized work is required. If the power remains on to the load center, preventing LOTOV, PPE must remain on for the duration of this task.
- Only trained and authorized personnel are permitted to perform this procedure.

## Hazards

Figure 7. Shock



Figure 8. Arc Flash



## Safety and PPE

- Insulated guarding mat

## AC Breaker - Remove

1. Remove the panel's dead front after putting on PPE. See [Remove a Dead Front on page 10](#).
2. Lockout/tagout the panel. See [Residential Panel LOTOV on page 7](#).
3. If load center is now de-energized, PPE may be relaxed.



**WARNING:** If the load center remains live during work, full shock and arc flash PPE must remain on for the rest of this procedure.

4. Turn off the breaker being removed. If there's a retention clip on the breaker mounting it to the load center, remove it with a screwdriver.
5. Use a screwdriver to remove the conductors from the breaker lugs.

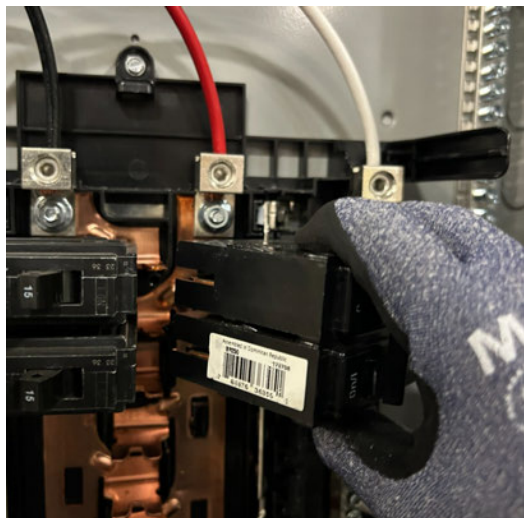


**NOTE:** Ensure the screwdriver tip doesn't damage conductor insulation



# RESIDENTIAL SAFETY PROCEDURES

6. Rock the breaker towards the side of the load center to remove it from the bus bars, and then pull outward to remove it.



7. Install a replacement breaker (see [Install an AC Breaker on page 18](#)) , or continue with other tasks in your work order.

## Install an AC Breaker

Correction code 100000052

### Overview

This procedure includes steps for installing an AC breaker in a residential panel.

### Prerequisites

- Replacement breaker with the correct amperage and model for the load center where it will be installed, and for the load it is connected to. Additionally, ensure that the wires connected to the breaker are the correct gauge for the breaker according to local electrical code.
- Only trained and authorized personnel are permitted to perform this procedure.

### Hazards

Figure 9. Shock



Figure 10. Arc Flash





# RESIDENTIAL SAFETY PROCEDURES

## Safety and PPE

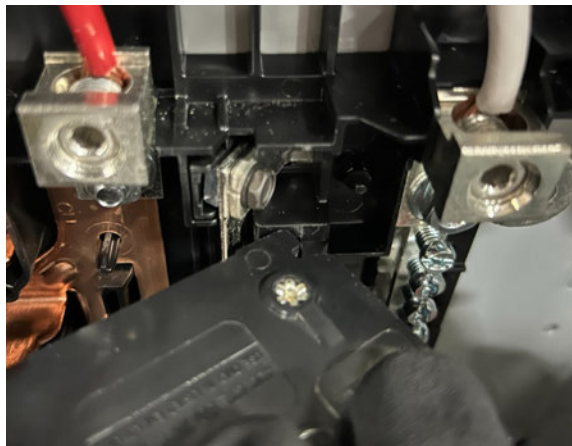
- Insulated guarding mat

## General Equipment

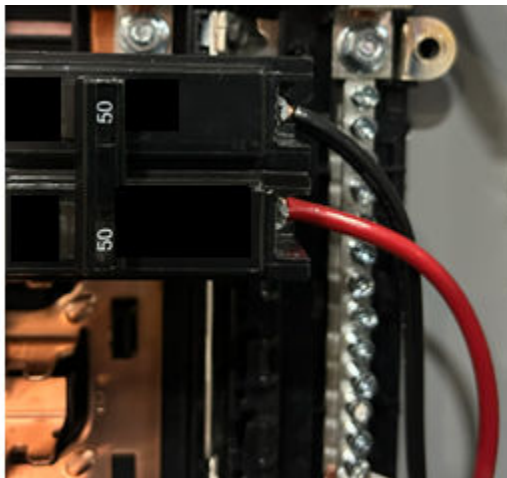
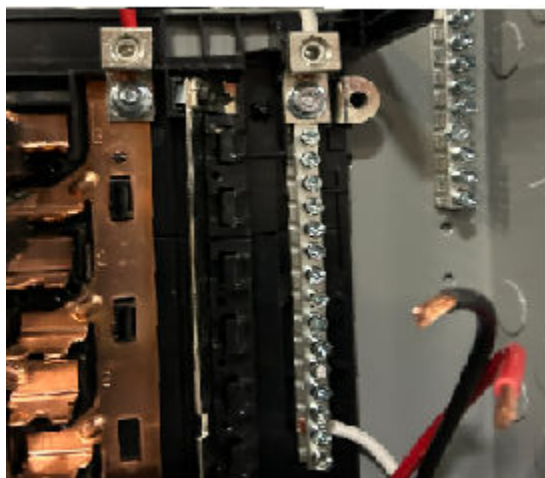
- Breaker

## AC Breaker - Install

1. Remove the panel's dead front. See [Remove a Dead Front on page 10](#).
2. Lockout/tagout the panel. See [Residential Panel LOTOV on page 7](#).
3. Take the new breaker out of its packaging. Confirm that new breaker is the correct amperage and model for the load center where it will be installed, and for the load it is connected to. Additionally, ensure that the wires connected to the breaker are the correct gauge for the breaker according to local electrical code.
4. Insert the plastic foot of the breaker into the clip and then pressing the breaker onto the panel bus bar.



5. Reinsert the wires into the breaker and tighten down the lug screws to secure them using a screwdriver. Follow the torque guidance on the breaker given by the manufacturer.



6. Replace the dead front and re-energize the panel. See [Replace a Dead Front on page 13](#).

## Electrical Utility Meter - Remove

Correction code 10003987



# RESIDENTIAL SAFETY PROCEDURES

## Overview

This procedure includes steps for removing a residential electrical utility meter.

## Prerequisites

- Before beginning this procedure, make sure that the local utility has approved the work, giving permission to break the seals and remove the meter.
- Pulling a utility meter may only be conducted by a qualified and authorized individual.

## Hazards

Figure 11. Shock



Figure 12. Arc Flash



## Safety and PPE

- Proving unit (Fluke PRV240 or equivalent)
- Insulated multimeter (Fluke 1587 FC or equivalent; rated for equipment voltage)
- Lockout/Tagout kit (locks, tags, hasps, lock box)
- Insulated guarding mat

## General Equipment

- Meter socket cover
- Wire cutters

## Electrical Utility Meter - Remove

1. Put on PPE. See [Put on Full Residential PPE on page 4](#)



## RESIDENTIAL SAFETY PROCEDURES

2. Place insulated guarding mat directly under the area where work will be conducted.



**NOTE:** Keep unqualified persons out of the work area when it's not electrically safe.

3. Inspect the meter and meter enclosure. Among the meter seal types, there are meters in enclosures with a utility drip ring and ringless meters that don't have a drip ring. If there's a special locked enclosure contact the local utility for removal.



**NOTE:** Do NOT pull a utility meter without approval from the utility. Sensors in the meter alert the utility when pulled.

4. Clip off the meter seal, using a pair of wire cutters. Remove the utility drip ring. (If it's a ringless meter enclosure, skip this step.)
5. Visually inspect the meter's encasement, checking for signs of cracks, moisture, fogging, damage, or tampering. No tools may be used to remove the meter dome; do NOT pry the dome off.
6. Grasp the dome of the meter, being careful to avoid touching metal. Rock the meter in an up and down steady motion to free the contact blades from the jaws. Do NOT rock side to side to avoid arc flash. Then, pull the meter strictly in the outwards direction.



**WARNING:** If the utility meter sockets are seized STOP immediately. DO NOT Proceed. Escalate to the utility company to plan a shutdown.



## RESIDENTIAL SAFETY PROCEDURES



7. Inspect meter lugs. If they are burnt, have burnt residue, show arcing, or have insulation bubbles, STOP work. Inform your supervisor. (Make sure to store the meter securely as Tesla is liable if the meter is lost.)



**WARNING:** This step is a visual inspection only. Assume load-side sockets are live until you complete live/dead/live tests. The line-side is always energized.

8. Open the meter enclosure. If there's a surge protector present, disconnect and remove it.
9. Prepare an insulated multimeter, inspecting its leads, probes, and fuse. Set the multimeter to AC. Using a known live source or proving unit, ensure the multimeter is operational and reads the correct value. If multimeter gives incorrect readings do not continue, substitute the meter for another one and repeat the check. Only move forward if the multimeter is functioning correctly.
10. Check the load-side sockets for dead. Using the insulated multimeter probes to test the load-side sockets. Verify that the line- and load-side terminals are not reversed. Verify voltage on the load side is 0 V AC (no more than 5 V AC) at:
- L1 - N (grounded conductor present)
  - L2 - N (grounded conductor present)
  - L1 - L2
11. Using a proving unit or a live voltage source, measure voltage again with the multimeter to ensure accurate values. If the multimeter does not show accurate readings substitute for another multimeter and repeat the previous check for dead steps.



## RESIDENTIAL SAFETY PROCEDURES

12. Mount the meter socket cover into the exposed sockets. Make sure the cover is seated firmly onto the sockets.



13. Close the meter enclosure.





# RESIDENTIAL SAFETY PROCEDURES

14. Lockout/tagout the meter. PPE may be relaxed at this point.



15. Continue with work as required.

## Insulation Piercing Connectors - Installed

Correction code 10003988

### Overview

This procedure includes steps for installing a line-side tap on a residential panel.

### Prerequisites

- Some utilities have stricter rules (or require utility involvement) for any line-side connection. Confirm with your supervisor before using this procedure.
- Where possible, contact the utility to schedule pulling the meter before performing a line-side tap. See [Electrical Utility Meter - Remove on page 19](#). If not, follow the steps below.
- Confirm the use of appropriately sized Insulation Piercing Connectors (IPCs; also known as B Taps) that fit the main line wires and tap wires.
- Verify that the range of the torque wrench supports the rated torque value required for the shear-head bolts to break off.



**CAUTION:** Do NOT use an impact drill on the IPC shear-head bolt.

- For older IPCs, the torque wrench should support the rated torque-control nut's torque value required to pierce the insulation of the wires; make sure to carry a socket that fits the breakaway head/torque control nut.
- Only trained and authorized personnel are permitted to perform this procedure.

### Hazards



# RESIDENTIAL SAFETY PROCEDURES

Figure 13. Shock



Figure 14. Arc Flash



## Safety and PPE

- Insulated guarding mat

## General Equipment

- Meter socket cover
- Insulation piercing connector(s) (IPCs)
- Torque wrench
- Socket that fits the breakaway head/torque control nut
- Permanent marker or paint pen
- Wire cutters

## Install Line Side Tap

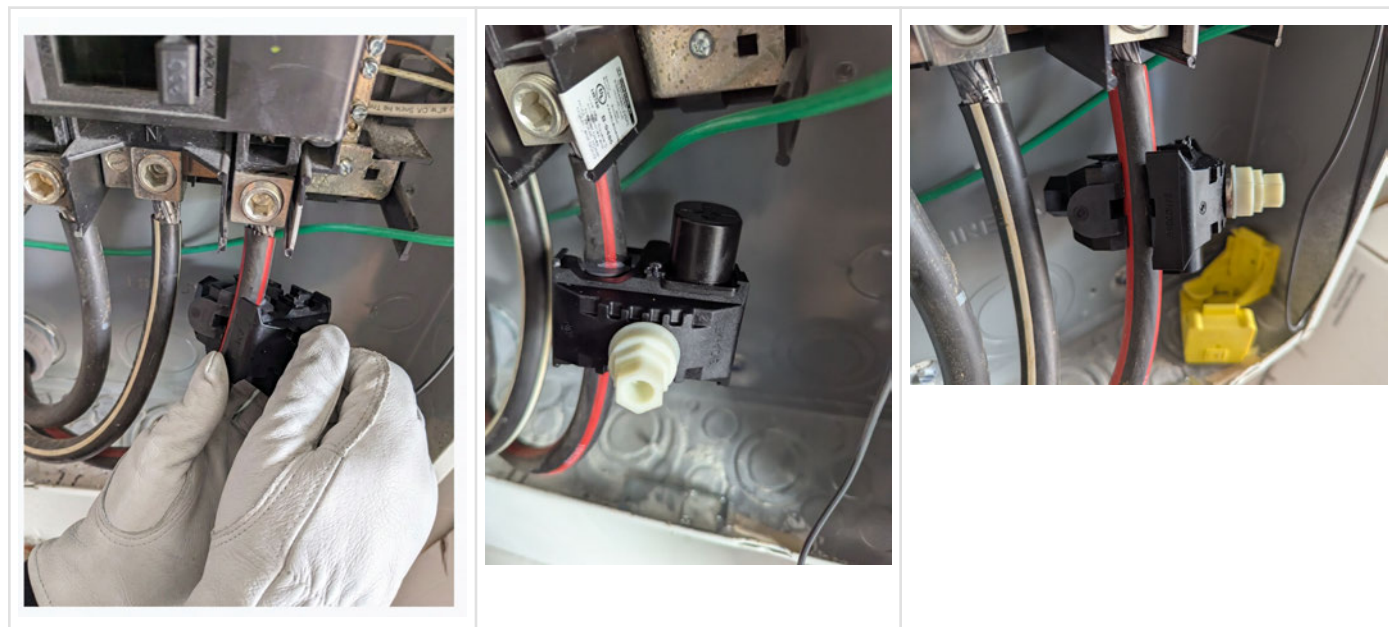
1. If included in work instructions and approved, pull the utility meter (see [Electrical Utility Meter - Remove on page 19](#)).
2. Remove the dead front of the panel impacted by this work after putting on PPE. See [Remove a Dead Front on page 10](#).
3. Use a wire cutter to cut the L1, L2, & N line tap wires to the lengths shown on engineering drawings. Do NOT strip the wires.
4. Ensure line tap wires are landed in disconnect before connecting them to an IPC.
5. Attach the connector's run side to a main line (L1/L2) or neutral (N) wire and secure it to the wire by rotating the shear-head bolt. Torque it until the connector grips the wire loosely.



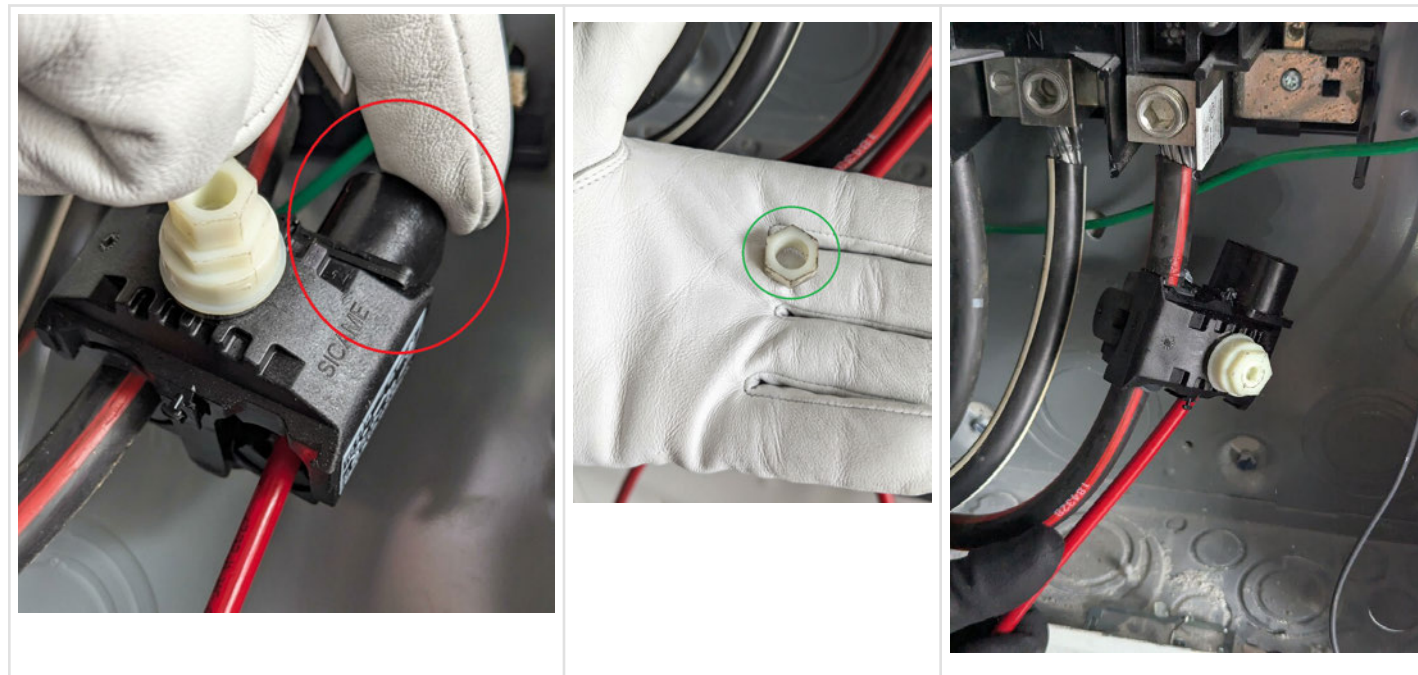
**NOTE:** Ensure the IPC is on a straight section of the main wire



## RESIDENTIAL SAFETY PROCEDURES



6. Attach the appropriately sized socket to the torque wrench. Insert the tap wire end to the tap side of the connector until it hits the closed end (circled in red in image attached). While holding the tap wire end inside the tap side, fixture the socket onto the shear-head/breakaway bolt (circled in green in the image). Torque the bolt to the rated torque value on the IPC until it snaps off using a torque wrench, causing the IPC to pierce the main line wire and tap wire to create an electrical connection.



7. If the IPC doesn't have a shear-head bolt but a torque-control nut, use the torque wrench to torque the bolt to the rated torque value (listed on the IPC). Do NOT exceed the torque limits specified by the IPC manufacturer.



**NOTE:** Ensure the tap wire end is inserted all the way to the back of the tap side of the connector if it doesn't have a closed end.



# RESIDENTIAL SAFETY PROCEDURES



- Repeat steps 4 - 6 for the other main (L1/L2) and Neutral (N) line tap wires.
- With a permanent marker or paint pen, draw torque marks on the IPC bolt head to indicate any loosening over time.
- Check for live voltage using an insulated multimeter (Fluke 1587 FC or equivalent). Inspect its leads, probes, and fuses. Verify the live voltage, using insulated probes, from the line-side lugs to the fuse disconnect breakers:

| Measurement | Expected Value |
|-------------|----------------|
| L1 - N      | ~120 V AC*     |
| L2 - N      | ~120 V AC*     |
| L1 - G      | ~120 V AC*     |
| L2 - G      | ~120 V AC*     |
| L1 - L2     | 240 V AC       |
| N - G       | < 1 V          |

\*If the value is outside ~110–126 V, escalate to your supervisor to conduct further investigation

- Replace the panel dead front and re-energize the panel. See [Replace a Dead Front on page 13](#).



# RESIDENTIAL SAFETY PROCEDURES

## Electrical Utility Meter - Energize

Correction code 10003987

### Overview

This procedure contains steps to re-energize a residential utility meter.



**WARNING:** Once the utility meter is energized, exposed conductors and terminals are energized. Wear all required electrical PPE while energized parts are exposed. Do not remove or downgrade PPE until the enclosure is closed and secured and no additional exposure to energized parts is required.

### Prerequisites

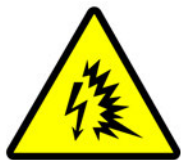
- Only trained and authorized personnel are permitted to perform this procedure.

### Hazards

Figure 15. Shock



Figure 16. Arc Flash



### Safety and PPE

- Insulated guarding mat
- Multimeter

### Utility Meter - Energize

1. Stage the work area. Remove any obstacles that block egress and identify a primary exit path.



**NOTE:** Keep unqualified persons out of the work area when it's not electrically safe.



## RESIDENTIAL SAFETY PROCEDURES

2. Place an insulated guarding mat directly under the area where work will be conducted.



3. Put on PPE. See [Put on Full Residential PPE on page 4](#). PPE must stay on until the task is complete.
4. Remove the lock and tag from the meter.



5. Open the meter enclosure. Remove the meter socket cover.



**WARNING:** Opening the meter enclosure exposes line-side components energized at 240 V. Treat all exposed line-side components as energized and maintain the required approach boundaries and PPE.



## RESIDENTIAL SAFETY PROCEDURES



6. If there was a surge protector installed previously, install and reattach. Ensure the surge protector's contacts are fully seated.
7. Perform a continuity test. Inspect the leads, probes, and fuse of an insulated multimeter and set it to measure Continuity. Ensure the multimeter is operational and reads continuity between the two testing probes. If multimeter gives no continuity readings do not continue; substitute the meter for another one and repeat the check.
8. Using insulated probes, measure on the load-side of the isolation point(s). Verify no continuity at each test point:
  - Each ungrounded conductor or exposed bus section to neutral/ground (L1–N/G, L2–N/G)
  - Phase-to-phase (L1–L2)
9. If no unexpected continuity is detected, continue. If any residual or unexpected continuity is present, **STOP**. Do not proceed with next steps. If it's safe to do so, re-verify isolation, sources, and metering. Otherwise, escalate to your supervisor.



## RESIDENTIAL SAFETY PROCEDURES

10. Close the meter enclosure. (If it's a ringless meter enclosure, don't close it.)



11.



**WARNING:** Do not connect the line-side terminals before the load-side terminals. If a load-side terminal contacts the grounded enclosure while the line side is connected, a short circuit or arc flash can occur, resulting in serious injury or death. **Connect the load-side terminals first.**

Reattach the load-side terminals into the two load-side sockets, then reattach the line-side, starting from the bottom to reattach the load-side sockets and tilting up to reattach the line-side. When the meter connects successfully both digital and analog indicators activate.





## RESIDENTIAL SAFETY PROCEDURES

12. Attach the utility drip ring and hang the meter seals around the drip ring's hook. (Skip this step if it's a ringless meter.)



13. Remove insulated mat and tools. Remove PPE. Restore area and clean up any debris.
14. Let the residents know that work is complete.

### Impedance Testing

Correction code 10003989

#### Overview

Impedance testing checks the electrical path to make sure current can flow properly and protective devices can operate as intended. Conducting impedance testing requires the use of a Fluke 1662 Multi-Function Tester. (View the [Fluke 1662 Multi-Function Tester user manual](#).)



**WARNING:** Exposed conductors are energized during impedance testing. Contact with energized conductors can result in electric shock, serious injury, or death. Wear the required electrical PPE and do not touch exposed energized conductors.



# RESIDENTIAL SAFETY PROCEDURES

## Prerequisites

- Only trained and authorized personnel are permitted to perform this procedure.
- Identify the system voltage, configuration, and test points before opening or accessing energized equipment.

## Hazards

Figure 17. Shock



Figure 18. Arc Flash



## Safety and PPE

- Insulated multimeter (Fluke 1587 FC or equivalent; rated for equipment voltage)

## Required Parts and Tools

- Fluke 1662 Multi-Function Tester

## Conduct Impedance Testing

1. Remove the dead front. See [Remove a Dead Front on page 10](#). Keep PPE on after removing the dead front.
2. Inspect the insulated multimeter leads, probes, and fuses.
3. Verify the live voltage, using insulated probes, on the load-side lugs:
  - L1–N: expect ~110–126 V AC
  - L2–N: expect ~110–126 V AC
  - L1–G: expect ~110–126 V AC
  - L2–G: expect ~110–126 V AC
  - L1–L2: expect ~240 V AC
  - N–G: expect < 1 V

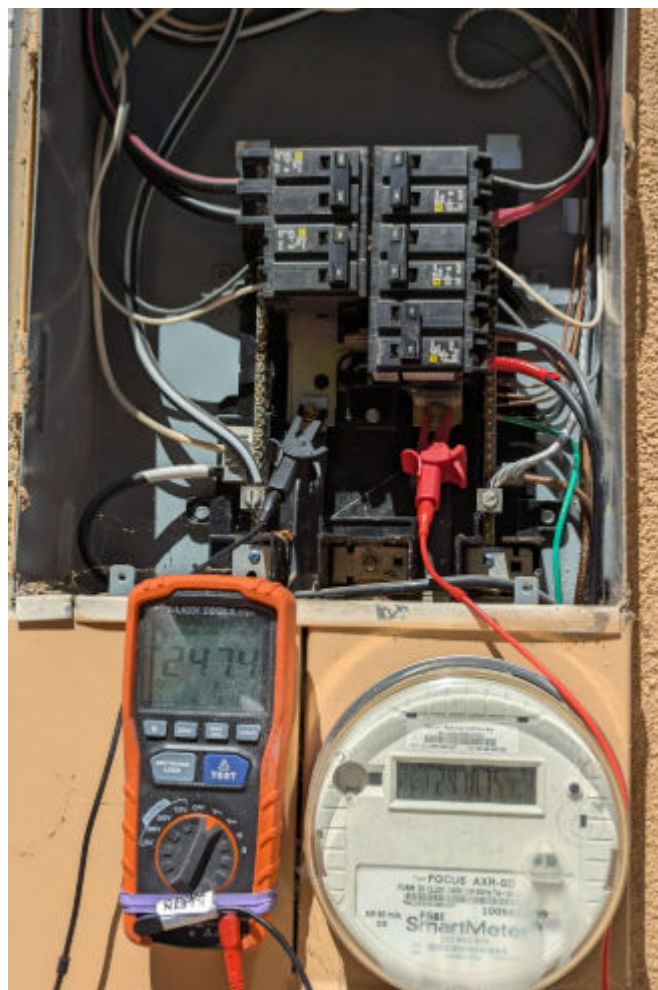


**WARNING:** All exposed conductors are energized. Contact with energized conductors can cause electric shock, serious injury, or death. Do not touch or contact exposed conductors. Use only insulated probes on a multimeter rated for the circuit.

Note down recorded values. If the value is outside the expected range, escalate to supervisor to conduct further investigation.



## RESIDENTIAL SAFETY PROCEDURES



4. Turn on the Fluke 1662 Multi-Function Tester , then connect the three clamps to each other. Rotate the dial to **Loop Zi No Trip**. Press and hold **F2** for 2-6 seconds to reset the unit to zero. A beep sounds to confirm that the tester and test leads are zeroed out.



**NOTE:** Always zero out the tester and the test leads before testing at a new site.



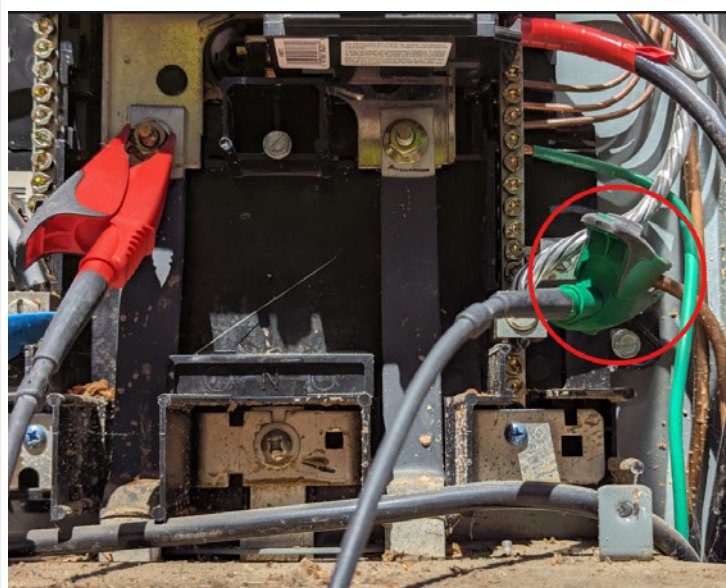
## RESIDENTIAL SAFETY PROCEDURES



5. Attach the **green clamp** to the **ground wire** to provide the most accurate reading (as shown in the left image below). Do NOT attach the green clamp to a lug or connector. Attach the **blue clamp** to the **line-side Neutral lug**. Attach the **red clamp** to the **line-side L1 lug**.



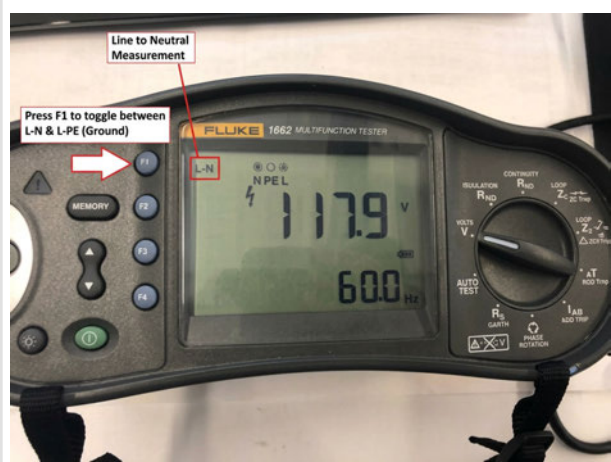
**WARNING:** Prevent line-to-line contact when attaching clamps. Contact between adjacent energized bus bars or conductors can cause an arc flash, resulting in serious injury or death. Maintain clearance between clamps and closely spaced energized parts.





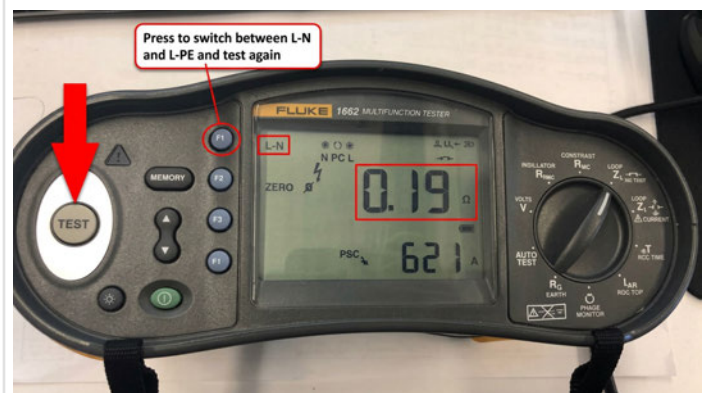
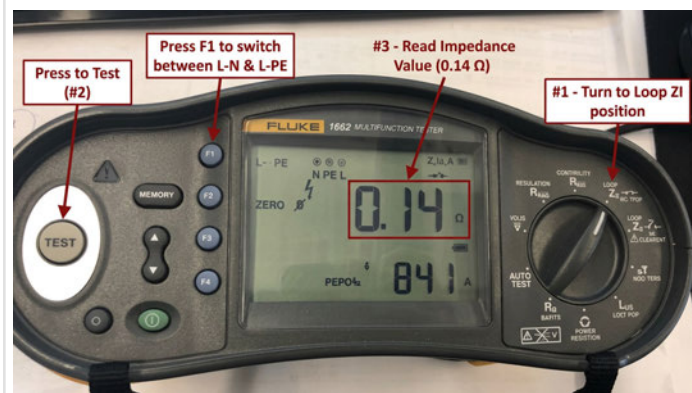
## RESIDENTIAL SAFETY PROCEDURES

- Turn the dial to **V** to check voltage, which verifies the connection with test leads. Press **F1** to toggle between Line to Neutral and Line to Ground (PE) voltage measurements. Verify that the values match the live voltage test values from [Remove a Dead Front on page 10](#).



- Turn the dial to **Loop Zi No Trip**. Press **Test** to take an impedance measurement. The device beeps and makes a clicking sound in the background while taking the measurement. Record the measurement, noting if the measurement is Line to Neutral or Line to Ground. Press **F1** to switch the tester to either **Line to Neutral** or **Line to Ground** and take another impedance measurement.

 **NOTE:** The value of impedance should never be 0 V.



- After taking impedance measurements on Line 1, repeat the measurements for Line 2. Repeat steps 5 -7.
- Remove the tester's clamps. Put away the tester.
- Replace the dead front. See [Replace a Dead Front on page 13](#).

## Residential Asbestos Control - North America

### Overview

In North America, Tesla has implemented an Asbestos Exposure Control Plan for the safety of all people present at a residential work site when drilling into outdoor building materials.



# RESIDENTIAL SAFETY PROCEDURES

When working on structures built prior to 1980, Tesla Energy teams face the risk of disturbing asbestos-containing material (ACM) used in roofing, adhesives, and siding. Once inhaled, asbestos fibers are not easily broken down. They become lodged in soft tissues causing irritation, inflammation, and scarring over decades which can lead to life-threatening conditions. The primary purpose of the Asbestos Exposure Control Plan is to outline the procedures put in place to protect employees and others from exposure to airborne asbestos fibers during work activities.

Employees may only perform drilling operations on Asbestos-Containing Material (ACM) or Presumed Asbestos Containing Material (PACM) provided the employee has completed all required training, maintains current refresher training, and strictly adheres to the wet drill method outlined below. All other activities involving ACM or PACM, including breaking, sawing, grinding, sanding, or otherwise making the material friable or airborne, are prohibited.

 **WARNING: ASBESTOS EXPOSURE HAZARD.** Disturbing asbestos-containing material can release carcinogenic fibers into the air. Perform this procedure only using the specified work methods and controls. Stop work if the material or work conditions differ from those evaluated, or if the required exposure controls cannot be maintained.

## Prerequisites

In order to be considered a competent person to perform this procedure, all of the Prerequisites below must be met.

- Completion of the 16-hour Class III Asbestos Operations and Maintenance training.
- Completion of the Tesla internal hands-on training for Class III Asbestos Operations and Maintenance which covers the wet-drilling method
- Current with any required Class III Asbestos Operations and Maintenance annual refresher training

 **WARNING: ASBESTOS EXPOSURE HAZARD.** Only personnel who have completed the required asbestos training and are authorized to perform this procedure may disturb suspected asbestos-containing material. Do not proceed if required training, authorization, PPE, equipment, or exposure-control measures are not in place.

## Hazards



**Asbestos (carcinogen / chronic health hazard).** Disturbing ACM/PACM can release fibers that lodge in the lungs and other tissue. Long-term disease outcomes can include asbestosis, lung cancer, and mesothelioma, often decades after exposure.



**Environmental hazard.** Debris or contaminated PPE can spread fibers outside the work area if containment, cleanup, or waste handling fails.



# RESIDENTIAL SAFETY PROCEDURES

**WARNING: ASBESTOS EXPOSURE HAZARD.** Stop work if the work method, equipment, material, exposure controls, or conditions change in a way that could increase asbestos exposure. If a release or work may exceed Class III or NEA limits, do not self-clean. Do not resume work until EHS has evaluated the change and authorized the work to continue. Additional air monitoring may be required. Exposure limits (US OSHA): PEL 0.1 f/cc (8-hour TWA); Excursion Limit (EL) 1.0 f/cc averaged over 30 minutes. In Canada, follow the applicable federal or provincial/territorial OEL.

## Safety and PPE

The PPE listed below is the minimum required when working with asbestos, and is in addition to any other PPE required by the task for technician safety.

- Disposable Tyvek coveralls with hood and booties
- Safety glasses
- Nitrile gloves

**NOTE:** Respiratory protection is not required for this procedure when performed under the conditions evaluated by the current negative exposure assessment (NEA). The NEA requires work be performed only by a Class III-trained technician outdoors, on intact non-friable siding, using the cup wet method (with a limit of ≤30 holes; <2.5 hours of work time). Air monitoring is repeated annually to verify that exposure remains below applicable limits. Refer to the North American Energy Asbestos Exposure Control Plan for the NEA and other details. Work only within the current NEA in the North American Energy Asbestos Exposure Control Plan (includes PEL/EL and monitoring).

## Required Parts and Tools

- Barricade tape, DANGER (red)
- OSHA-compliant warning signs to post at entry points
- Rotary drill
- Masonry bit
- 6 mil bags, 33 gal capacity, labeled for asbestos waste disposal (order from Grainger)
- Zip ties
- Cloths
- Plastic sheeting
- Shaving cream
- 4oz paper cups
- Duct tape (one or more rolls)
- HEPA vacuum

## Pre-Work Asbestos Control Process

The following steps outline the ideal process for residential asbestos control.

1. A site survey is conducted for asbestos identification, and to check for potential ACM. This information is added to a Job Hazard Analysis (JHA). If ACM is suspected, the JHA includes the type of material (friable or non-friable), the OSHA class (I-IV), and an Asbestos Work Plan (AWP).
2. If an area of Asbestos-Containing Material (ACM) or Presumed Asbestos Containing Material (PACM) is identified, immediately stop working and call a Take 5; contact the Field Manager or Site Supervisor and inform EHS to escalate the situation.



# RESIDENTIAL SAFETY PROCEDURES

3. The EHS representative and a Certified Industrial Hygienist (CIH) perform a job review to determine if work must be stopped or if there is a path forward.
4. Once EHS and Industrial Hygiene are in alignment, the plan for moving forward with work or canceling the job is documented. If the job moves forward, a written plan for wet drilling is completed and signed by EHS, IS, Field Manager/Site Manager. Without a signed plan, no work may begin.

## Exposure Control Methods

### Work Area Isolation

Follow these steps to isolate the work area where asbestos may be present. Once the area is isolated, work can begin.

 **WARNING: Do not eat, drink, smoke, chew gum, or apply cosmetics while working in or around suspected or confirmed asbestos-containing materials.** Asbestos fibers can contaminate food, beverages, hands, and tobacco products, resulting in exposure through hand-to-mouth contact. Before eating, drinking, smoking, chewing gum, or applying cosmetics, decontaminate as required and thoroughly wash your hands and face.

1. Speak to residents, asking them to avoid the area where drilling and mounting/conduit installation will occur. Ask that they keep pets secured indoors during the procedure.
2. Shut off HVAC systems to prevent fiber spreading.
3. Inspect the Tyvek coveralls for tears, holes, or damaged closures.
4. Put on the coveralls without contacting potentially contaminated surfaces.
5. Fully fasten the front closure, then don the hood.
6. Don safety glasses, and nitrile gloves. Make sure sleeves overlap with gloves to avoid exposed skin.
7. To keep unqualified individuals away from the work area, demarcate the area with the Danger barricade tape.
8. Post warning signs at every entry point to the area. The signs must read, "DANGER: ASBESTOS MAY CAUSE CANCER. CAUSES DAMAGE TO LUNGS. AUTHORIZED PERSONNEL ONLY."
9. Place plastic sheeting beneath the work location to capture any material or debris that may fall to prevent contamination of surrounding surfaces; secure the plastic to the exterior of the home with duct tape if there is wind. Position the sheeting to cover the area where material could reasonably fall. If any material lands off the plastic sheeting, contact EHS for next steps.

### Wet Method to Suppress Asbestos Fiber Release

For this procedure, holes are drilled through a cup filled with shaving cream to keep material damp. Keeping material damp prevents asbestos fibers from becoming airborne when drilling. Dry asbestos is dangerous as it becomes airborne and can be inhaled. Wet asbestos stays bound to material and falls to the floor instead of floating. Wet methods are techniques that use a water or surfactant to suppress asbestos fiber release during work.

During drilling, if the shaving cream starts to dry out, stop drilling. Apply additional shaving cream to maintain a wet barrier and capture dust and debris. Do not resume drilling until the wet-control method has been restored.

 **WARNING: ASBESTOS EXPOSURE HAZARD** Perform this procedure outdoors only. Do not perform this procedure indoors or in an enclosed or partially enclosed space. The exposure controls in this procedure were evaluated for outdoor conditions only. Do not perform this procedure if visible dust is present.

1. Put on Tyvek coveralls, eye protection, and nitrile gloves as instructed above.
2. Open an asbestos disposal bag so it's ready when needed.
3. Fill a paper cup with shaving cream.
4. Secure the masonry bit into the rotary drill.



## RESIDENTIAL SAFETY PROCEDURES

5. Prepare to drill only where the ground below is covered by plastic sheeting. Confirm that the sheeting is secured if it's windy; make any adjustments before drilling.

6.  **WARNING:** Never use a hammer drill, rotary hammer, or hammer/impact mode for this procedure. Impact drilling can release hazardous asbestos fibers into the air and increase inhalation exposure. Use only the approved tools and method as described in this procedure.

Punch the drill bit through the bottom of the cup. It will pass through the shaving cream and extend past the opening of the cup.

7. Press the open end of the cup firmly against the siding surface over the intended drill location, so the shaving cream makes contact and seals around the surface.
8. With the rotary drill set to a low speed, begin to drill through the siding. The shaving cream captures dust and debris as it is generated, encapsulating fibers in the foam. Keep the cup pressed firmly against the surface throughout the entire drilling operation; do not pull back until drilling is complete. If shaving cream, dust, debris, or other potentially contaminated material contacts the face or exposed skin, stop work immediately and contact the site supervisor.

9.  **WARNING: ASBESTOS EXPOSURE HAZARD.** If the collection cup tears, falls, loses contact with the surface, or if the shaving cream dries out, stop work immediately. Do not disturb or attempt to clean up released material. Keep personnel away from the affected area and contact EHS for instructions. Do not resume work until authorized and the required containment controls are restored.

Withdraw the drill slowly while keeping the cup in place to capture any remaining debris.

10. Remove the cup carefully. Fold or close the cup around the captured material and immediately place it in the asbestos disposal bag.
11. Continue with installation.
12. Repeat the process with a new cup for any additional holes that need to be drilled (maximum ≤30 holes).
13. When work is complete, follow the instructions in *Cleaning Up and Removing PPE*.

### ***Cleaning Up and Removing PPE***

After work is complete, follow the instructions below to clean up the work site and dispose of PPE and materials properly. Always make sure to complete cleanup, PPE removal, and handwashing before leaving the site or entering a vehicle.

-  **WARNING: ASBESTOS EXPOSURE HAZARD:** Do not perform routine cleanup if material has escaped the established containment area or a containment control has failed. Stop work, restrict access to the affected area, and contact EHS for instructions before reporting a [Near Miss Incident](#).

1. Use damp wipes to clean up any debris; a HEPA vacuum may also be used if needed. Make sure all cup(s), shaving cream, and wipes are placed in the asbestos waste bag.
2. Next, prepare to dispose of the plastic sheet. Do not shake, sweep, or brush debris from sheeting. Starting at the outer edges, carefully fold the sheeting inwards, toward the center. Keep the potentially contaminated surface inside the folds. Maintain control of the sheeting so wind doesn't lift or disturb it or any debris on the sheeting.
3. Keep any visible debris contained within the folded sheeting. Fold or roll slowly to avoid generating airborne dust or allowing debris to escape.
4. Place the folded sheeting directly into the designated asbestos waste bag. If material spills from the sheeting or contamination is found outside the controlled area, stop and contact EHS rather than attempting an unapproved cleanup.



## RESIDENTIAL SAFETY PROCEDURES

5. Take down the DANGER barrier tape and the warning signs. If the tape and signs remain visually clean, they can be thrown away as regular trash or re-used if desired. However, if the warning signs and/or barriers are potentially contaminated, place them into the asbestos waste bag.
6. Perform a final cleanup and inspection of the work area.

7.



**WARNING: ASBESTOS EXPOSURE HAZARD.** The outside of disposable coveralls may be contaminated with asbestos fibers. Remove them slowly by peeling the garment away from the body and turning the contaminated surface inward. Avoid contact between the outside of the coveralls and skin, personal clothing, or clean surfaces.

Remove Tyvek coveralls, first rolling hood away from the head. Carefully unzip the coveralls, making sure to not touch clothing or skin with the outside of the garment. Working downwards, peel the coveralls away from the body, turning them inside out as they are removed.

8. Step out of coveralls, one foot at a time.
9. Remove nitrile gloves without touching the exterior by peeling them off inside out, glove in glove.
10. Put Tyvek coveralls and nitrile gloves in the asbestos waste disposal bag.
11. Pour water into the bag, wetting down the materials inside.
12. Tie the bag, then tape it shut. Place the bag into a second asbestos waste disposal bag. Use a zip tie to secure it closed.
13. Label the bag "Asbestos Waste" with a black marker.
14. Wash hands and any exposed skin thoroughly with soap and water immediately after handling potentially contaminated PPE and waste.
15. Let the residents know that work is complete and that the area is safe.
16. Coordinate with the local warehouse for a drum. Place the double-bagged waste in the drum and store it in the waste accumulation area. Apply the NA2212 Waste Label on the drum and fill out the start date. Submit shipment via waste shipment request forms or QR codes. Refer to the North American Energy Asbestos Exposure Control Plan for proper labels and additional information.

### Emergency Procedure During or After Work

If an unexpected release of asbestos fibers occurs, do the following.



**WARNING: ASBESTOS EXPOSURE HAZARD.** Do not clean up or disturb released material. Cleanup can release hazardous asbestos fibers into the air and increase inhalation exposure. Stop work, keep personnel away from the affected area, and contact EHS for assistance before reporting a [Near Miss Incident](#).

1. Stop work immediately. Do NOT attempt containment or self-clean.
2. Evacuate the area. Remain outside, and move away from the area where drilling occurred.
3. Notify management, starting with the Site Supervisor.
4. Wait for instructions from EHS.
5. File a [Near Miss Incident](#).

### Common Sources of Suspected Asbestos-Containing Materials (ACM)

The following items **should be handled as though they do contain asbestos until lab results prove otherwise**. Any material suspected to contain asbestos must be considered PACM until bulk samples of the material sent to a certified American Industrial Hygiene Association laboratory prove otherwise. Tesla Industrial Hygiene provides guidance after reviewing the laboratory results.



## RESIDENTIAL SAFETY PROCEDURES

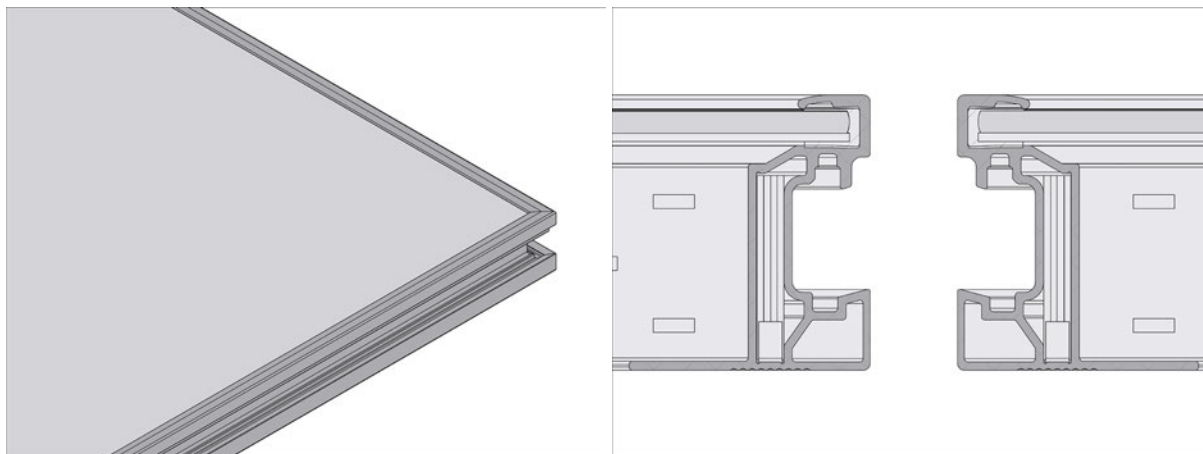
- **Flooring.** Vinyl floor tiles (9"x9") and 12"x12"), sheet flooring (linoleum), flooring backing, asphalt floor tile, and associated mastics/adhesives.
- **Walls and Ceilings.** Popcorn texture, acoustic plaster, decorative plaster, wallboard, drywall, joint compounds, spackling, and textured paint.
- **Insulation (TSI).** Pipe insulation (corrugated air-cell), boiler and tank insulation, furnace duct tape, blown-in insulation, and vermiculite.
- **Roofing and Siding.** Cement siding, roofing shingles, roofing flashing, and silver roofing paint.
- **Electrical.** Electrical cloth, wiring insulation, electrical panel partitions (ebony board), and arc shields.
- **Miscellaneous.** Caulk, window glazing, fire doors, fire blankets, elevator brake shoes, cooling towers, and laboratory tabletops.



# INTRODUCTION TO TESLA PANEL MOUNT SYSTEM

## Tesla Solar Compatible

Tesla Solar mounting solutions are based on the Tesla Groove, a patented module frame profile designed to mate easily and precisely with Tesla Solar components, creating a structural and/or electrical bond with a simple drop-in motion.

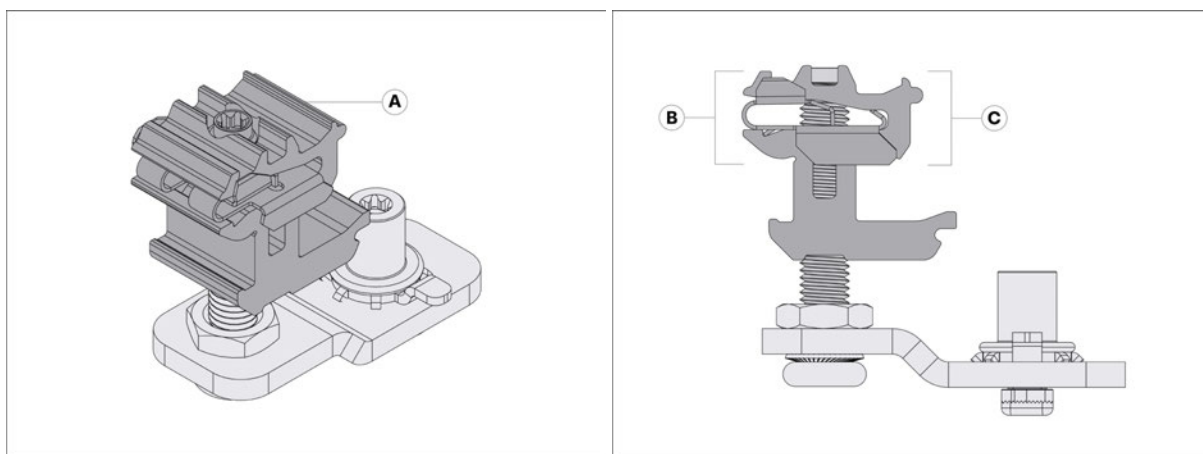


- PV module frame with Tesla Groove

## The Key and Tongue Concept

The Key and Tongue concept informs all Tesla Solar Compatible designs. The Key side inserts into the Tesla Groove, similar to inserting a key into a lock. On the other side, the Tesla Groove allows PV modules to drop in easily onto the Tongue. This Key and Tongue system allows automatic structural connection and electrical bonding as the modules are dropped in to the components below.

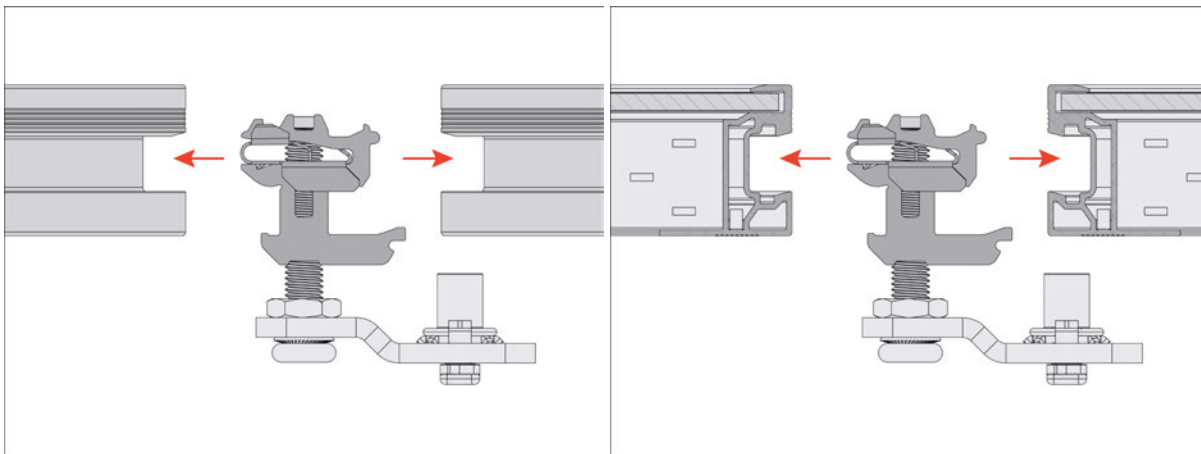
For example, the Rockit is a hardware component used to secure PV modules to the roof attachments. The Rockit fits into the Tesla Groove on both sides: The Key side inserts, while the Tongue side receives.



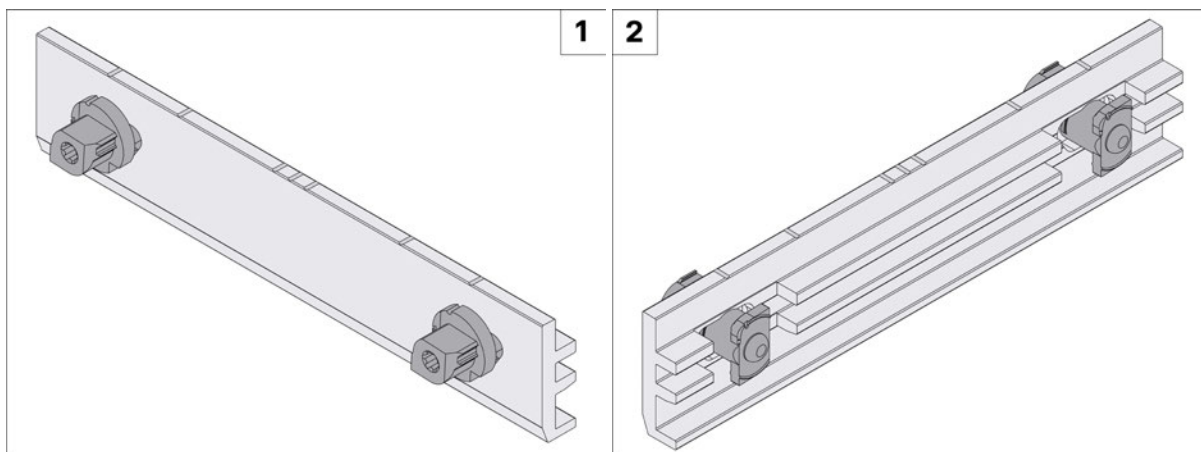
- A - Rockit
- B - Key side
- C - Tongue side



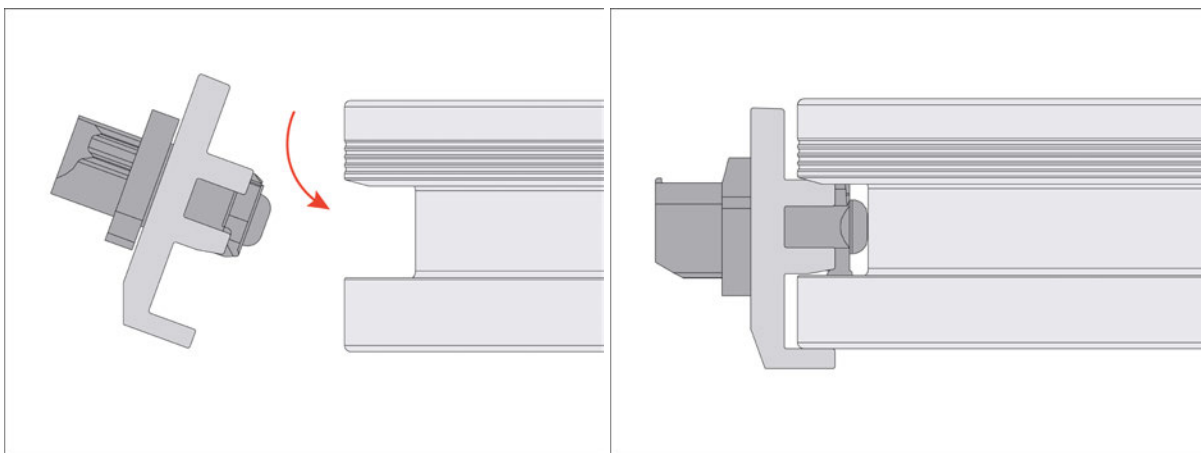
# INTRODUCTION TO TESLA PANEL MOUNT SYSTEM



The Key and Tongue design is also used with the Interlock, a component that mechanically connects and bonds two modules together. Here, the Key and Tongue are differently shaped, but they fit into the Tesla Groove in a similar manner to the Rockit.



- A - Interlock front is the Tongue side
- B - Interlock back is the Key side

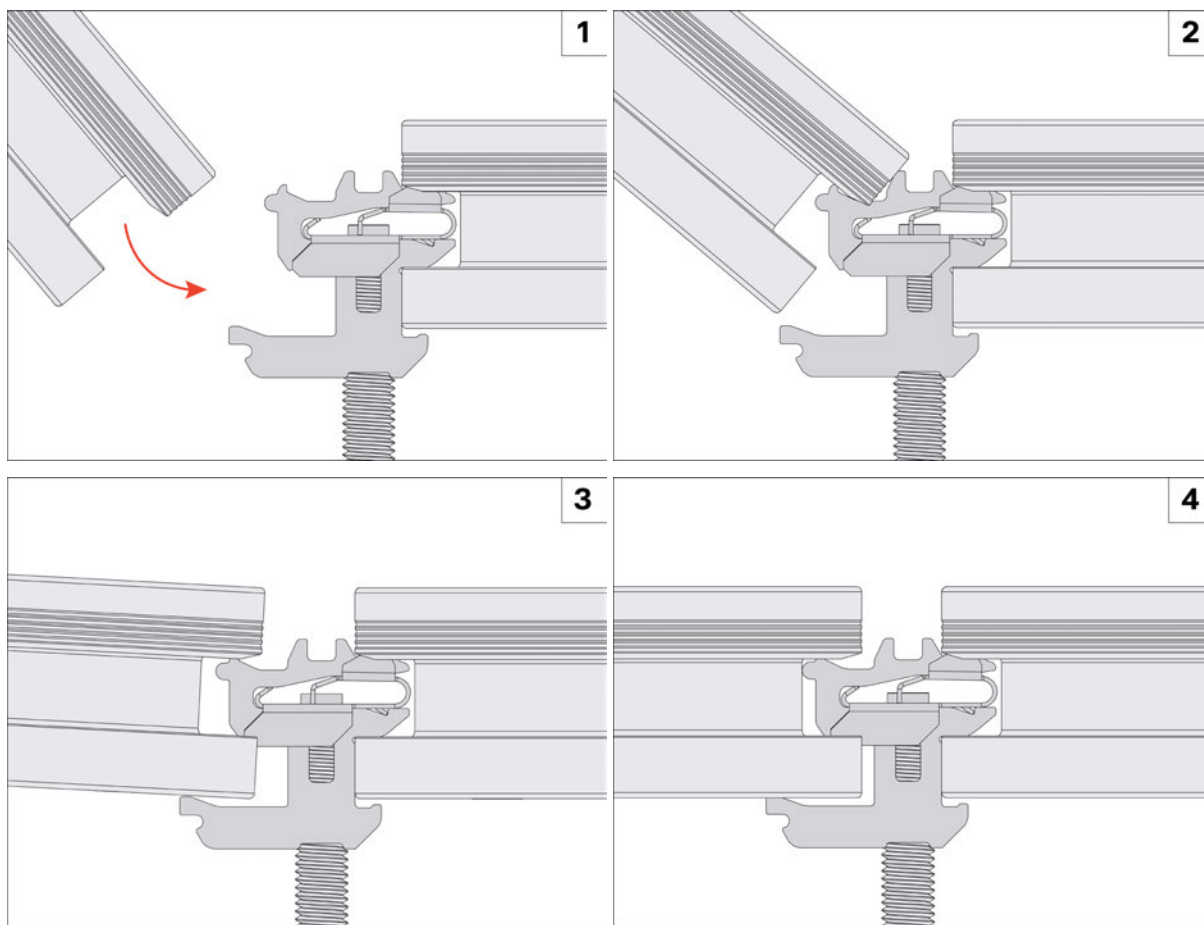


## Module Drop-In

Tesla Solar Compatible modules are dropped in to the Rockit with a downward motion as shown (1). The module's downward motion creates forced interference with the Tesla Groove of the module frame (2), cutting through the frame coating (3) to create an electrical bond and structural connection (4).



# INTRODUCTION TO TESLA PANEL MOUNT SYSTEM



## System Height

When installed with Tesla Groove compatible mounting hardware, the system height between the roof sheathing and underside of the modules will have a range between 76 mm and 252 mm.



## SPECIFICATIONS

### Electrical Characteristics

| Model                               | TSP-415                              | TSP-420       |
|-------------------------------------|--------------------------------------|---------------|
| Max Power, $P_{MAX}$ (W)            | 415 W                                | 420 W         |
| Open Circuit Voltage, $V_{OC}$ (V)  | 40.92                                | 40.95         |
| Short Circuit Current, $I_{SC}$ (A) | 12.93                                | 13.03         |
| Max Power Voltage, $V_{MP}$ (V)     | 34.24                                | 34.29         |
| Max Power Current, $I_{MP}$ (A)     | 12.12                                | 12.25         |
| Module Efficiency                   | $\geq 20.3\%$                        | $\geq 20.5\%$ |
| STC                                 | 1000 W/m <sup>2</sup> , 25 °C, AM1.5 |               |

Rated electrical characteristics are within 10 percent of measured values at Standard Test Conditions of: 1000 W/m<sup>2</sup>, 25°C cell temperature and solar spectral irradiance per IEC 60904-3 or irradiation of AM1.5 spectrum.

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  $I_{SC}$  should be multiplied by a factor of 1.25 and  $V_{OC}$  by a factor of up to 1.25 when determining component voltage ratings, conductor capacities, fuse sizes and size of controls connected to the module output.

### Temperature Rating (STC)

|                               |            |
|-------------------------------|------------|
| Temp Coefficient of $I_{SC}$  | +0.004%/°C |
| Temp Coefficient of $V_{OC}$  | -0.27%/°C  |
| Temp Coefficient of $P_{MAX}$ | -0.34%/°C  |

### Mechanical Loading

|                        |                   |
|------------------------|-------------------|
| Front Side Design Load | 2873 Pa (60 psf)  |
| Rear Side Design Load  | 2873 Pa (60 psf)  |
| Front Side Test Load   | 4309 Pa (90 psf)  |
| Rear Side Test Load    | 4309 Pa (90 psf)  |
| Hailstone Test         | 35 mm at 27.2 m/s |

Refer to module and system installation manuals for allowable design loads, foot spacings, and cantilever specifications.

### Mechanical Parameters

|                  |                |
|------------------|----------------|
| Cell Orientation | 360 (6 x 60)   |
| Junction Box     | IP68, 3 diodes |



## SPECIFICATIONS

|             |                                                         |
|-------------|---------------------------------------------------------|
| Cable       | 4 mm <sup>2</sup> (12 AWG) 1000 mm (39.4 in)            |
| Connector   | Staubli MC4 (PV-KBT4/6II-UR, PV-KST4/6II-UR)            |
| Front Cover | 0.13 in. (3.2 mm) Thermally Pre-stressed Glass          |
| Frame       | Black Anodized Aluminum Alloy                           |
| Weight      | 22.2 kg (49.0 lb)                                       |
| Dimensions  | 1805 mm x 1135 mm x 40 mm (71.1 in x 44.7 in x 1.57 in) |

### Operation Parameters

|                                             |                    |
|---------------------------------------------|--------------------|
| Operating Temperature                       | -40 °C to +85 °C   |
| Power Output Tolerance                      | +15/-0 W           |
| V <sub>OC</sub> & I <sub>SC</sub> Tolerance | +/- 5 %            |
| Max System Voltage (V <sub>SYS</sub> )      | DC 1000 V (IEC/UL) |
| Max Series Fuse Rating                      | 25 A               |
| Safety Class                                | Class II           |
| Fire Rating                                 | UL 61730 Type 2    |



## TRANSPORTATION AND STORAGE

Store modules in original packaging in a cool, dry area until installation.

Inspect packaging for damage.



**WARNING:** Do not install modules with visible damage.

Ensure that all personnel handling modules are aware of safety precautions and using appropriate personal protective equipment.

Unpackaged modules should not be stacked or subjected to mechanical stress or impacts, and should not be walked on.

Do not modify wires or connectors or drill holes in the module frame.



# INSTALLATION

## Mounting Instructions

Tesla Solar Panels (TSP-415 – TSP-420) are manufactured with a proprietary frame groove for use with UL 2703 listed mounting systems including Tesla Panel Mount - Comp Rafter, Tesla Panel Mount - Tile, Tesla Panel Mount - Metal, Tesla Panel Mount - Flat, and Zep solutions including ZS Comp, ZS Span, ZS Seam, and ZS Ramp. The PV module frames are mechanically connected by Interlocks, creating continuous beams and eliminating the need for mounting rails. The system is installed with simple tools and electrical bonding is integrated, enabling fast and easy installation.

The PV module drop-in process is specific to Tesla Panel Mount designs. Roof attachments connect to the rafters which run in the Y direction. Modules are dropped in row by row going up-roof beginning at the Front Skirt, which is nearest to the eave. The Front Skirt must always be installed along the X-axis. Modules must never be installed at an angle relative to the rafters.

## Roof Mounting Hardware

Tesla mounting solutions including components such as Rockits, Lockits, and Interlocks are designed for use with Tesla Solar Panels.

Follow the appropriate steps for array layout and installation of the rooftop mounting hardware, including the roof attachments and Rockits at the down-roof edge of the first module row.

| Manufacturer | Mounting Hardware                  | Installation Manual                                                 |
|--------------|------------------------------------|---------------------------------------------------------------------|
| Tesla        | Tesla Panel Mount - Comp Rafter    | <a href="#">Tesla Panel Mount - Comp Rafter Installation Manual</a> |
|              | Tesla Panel Mount - Tile           | <a href="#">Tesla Panel Mount - Tile Installation Manual</a>        |
|              | Tesla Panel Mount - Metal          |                                                                     |
|              | Tesla Panel Mount - Flat           |                                                                     |
| Zep Solar    | ZS Comp, ZS Span, ZS Seam, ZS Ramp | <a href="#">Solar PV Retrofit Installation Manual</a>               |

## Wiring

### Introduction

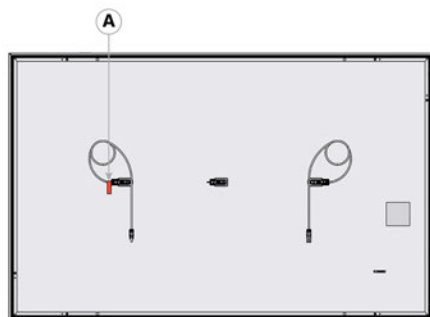
Tesla Solar Panels are optimized for landscape installation. Side to side connections minimize the need to reach under the array to manage wires.



**WARNING:** Do not exceed the voltage limit of the inverter when connecting panels in series.



# INSTALLATION



- (A) - The positive lead is marked with a red tag.

## String Planning

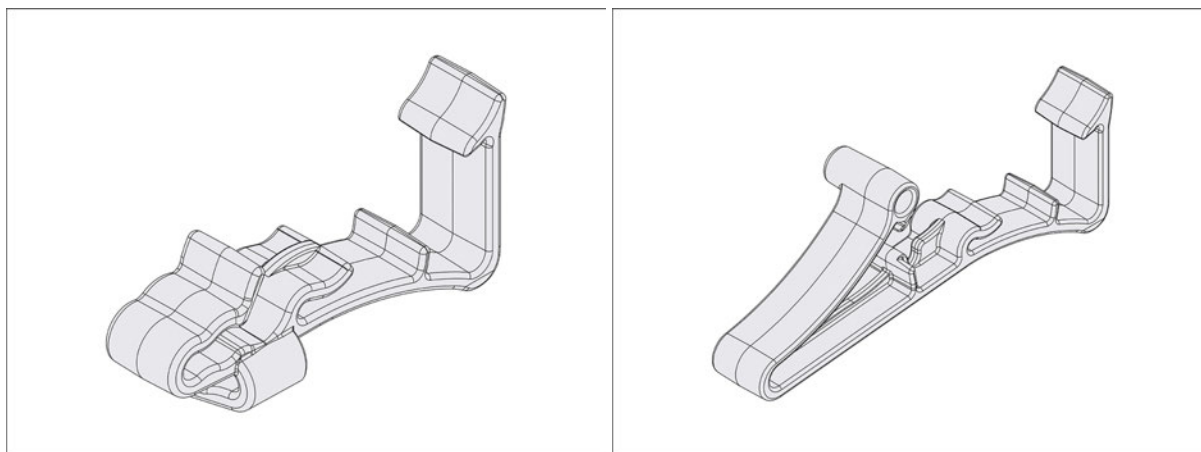
Draw the stringing path before connecting modules and keep a completed string diagram indicating the layout of the array and the placement of each MCI (either a paper copy, electronic copy available in the field, or both). Refer to [Appendix B: Wire Management Recommendations on page 71](#).

Rotating the direction of modules in subsequent rows minimizes the number of up-roof/down-roof connections in the array for easiest wire management.

Consider combiner box placement, conduit run, and inverter location when stringing modules. Place home runs near the inverter for the shortest possible path.

## Wire Clips

Wire clips fit into the same groove in the panel frame as the mounting hardware and are used to secure PV wires in place. There are two configurations of wire clips, as shown below:

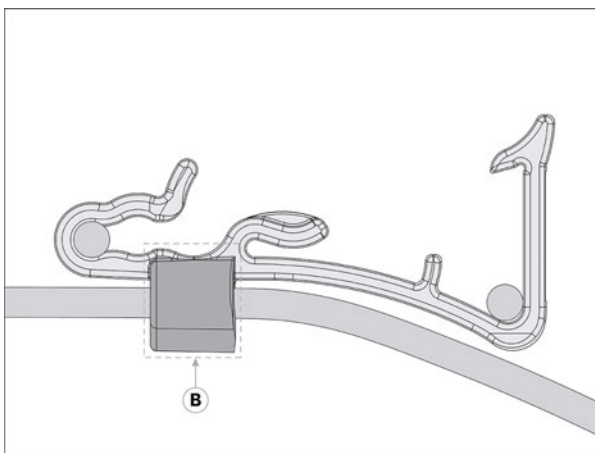
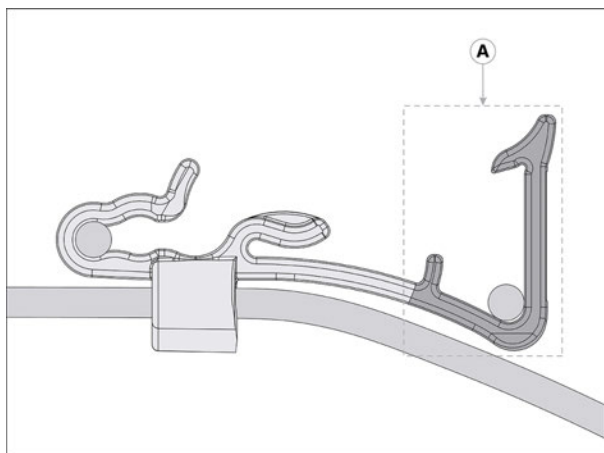


1. DC Wire Clip
2. Home Run Wire Clip

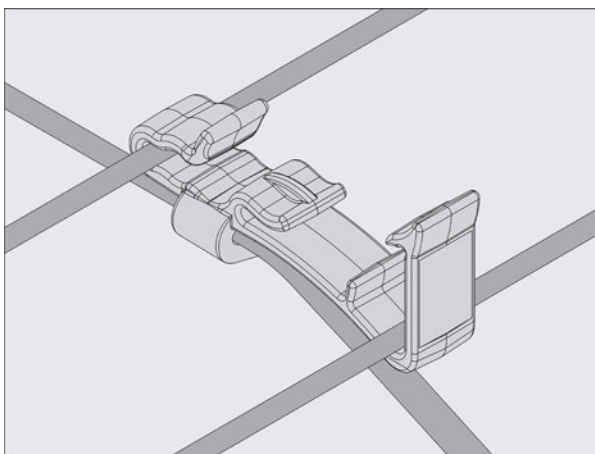
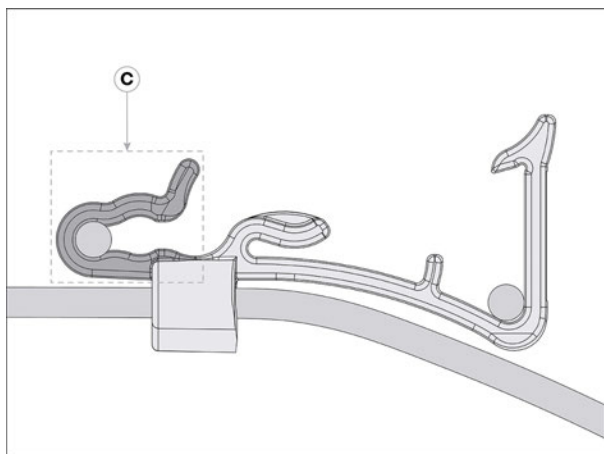
The DC Wire Clip has three areas that can hold PV wires.



## INSTALLATION

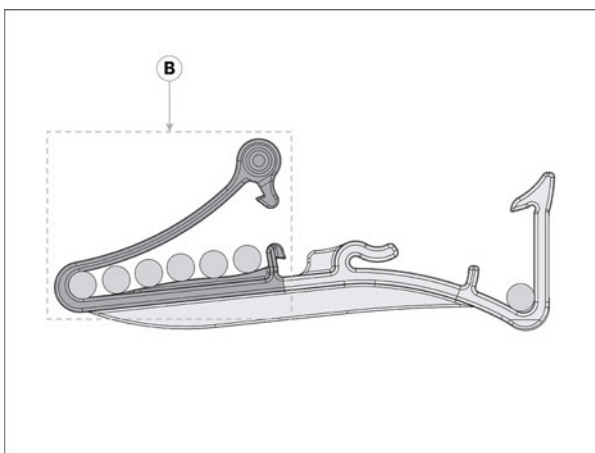
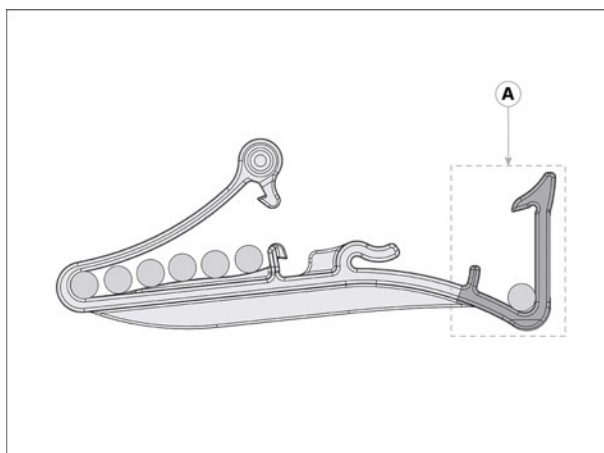


- (A) - Front basket
- (B) - Perpendicular clip



- (C) - Back clip
- DC Wire Clip holding three wires.

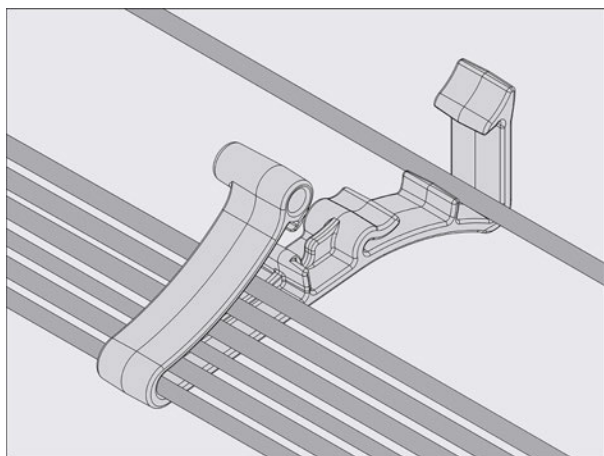
If more than two wires need to travel along any edge of a module the Home Run Wire Clip can be used. It holds 6x 10 AWG wires or 4x 8 AWG wires and installs in a similar fashion to the DC Wire Clip.



- (A) - Front basket
- (B) - Multi wire clip

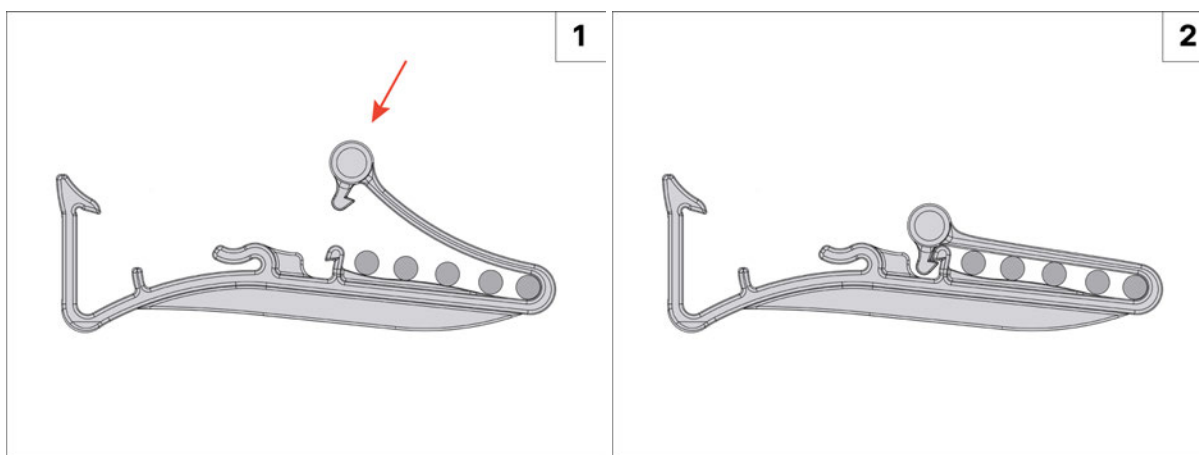


# INSTALLATION

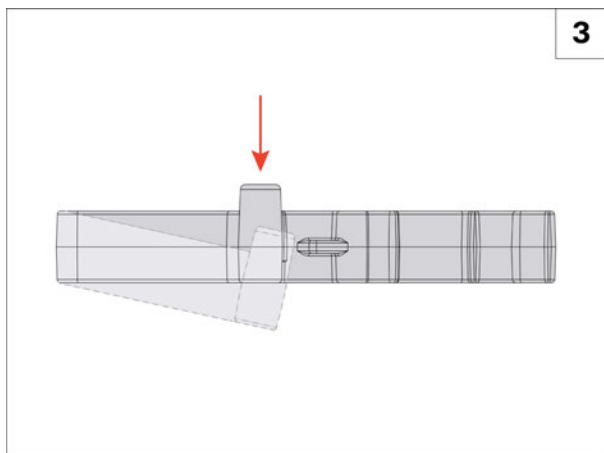


- Home Run Wire Clip holding 7 PV wires

Close the Home Run Wire Clip by snapping the clip together. To open the clip, push the tab to the side.



- (1) - Close the Home Run Wire Clip by snapping the clip together
- (2) - Closed Home Run Wire Clip



- (3) - To open the clip, push the tab to the side

## Wire Clip Placement

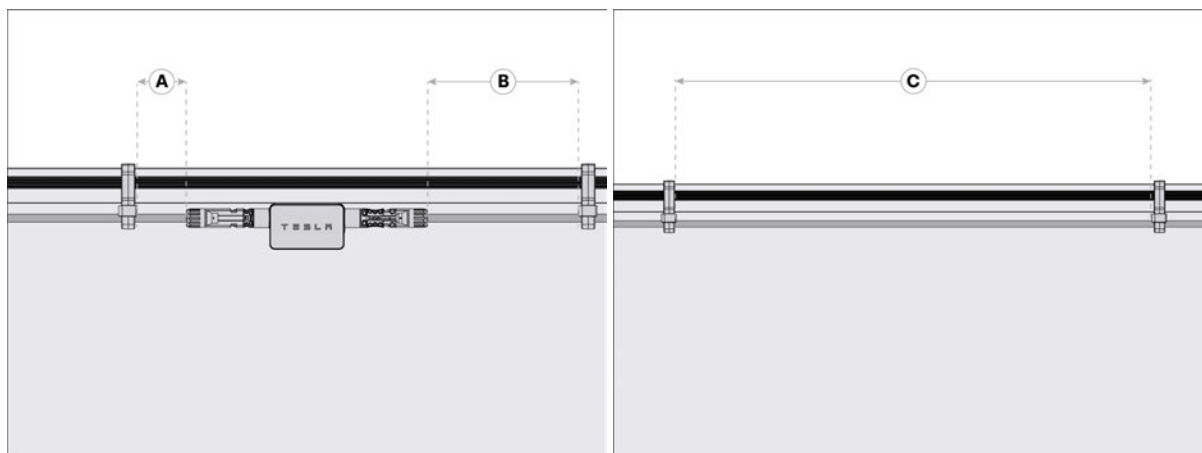
### Placement Rules



# INSTALLATION

NEC 690.31(C)(1)(b) specifies that there must be a wire clip every 24 in. (600 mm).

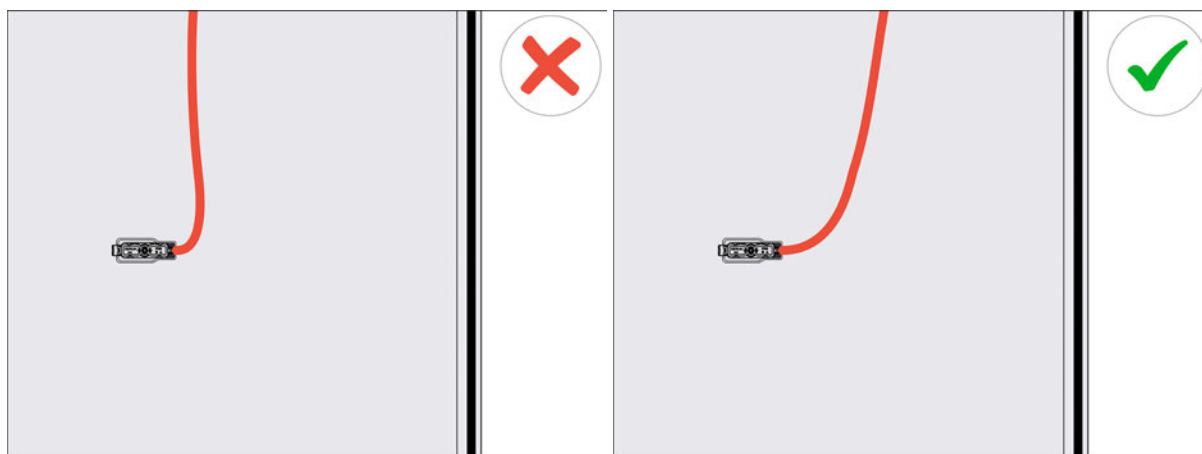
Wire clips should be at least 2 in. (50 mm) but not more than 6 in. (150 mm) from the connectors.



- (A) - Minimum distance between DC Wire Clip and connector (2 in)
- (B) - Maximum distance between DC Wire Clip and connector (6 in)
- (C) - Maximum distance between DC Wire Clips (24 in)

## Bend Radius

Ensure that the wires are not under mechanical stress. Minimum bending radius is 5x the wire diameter, generally  $\geq 1 \frac{1}{4}$  in. (30 mm).

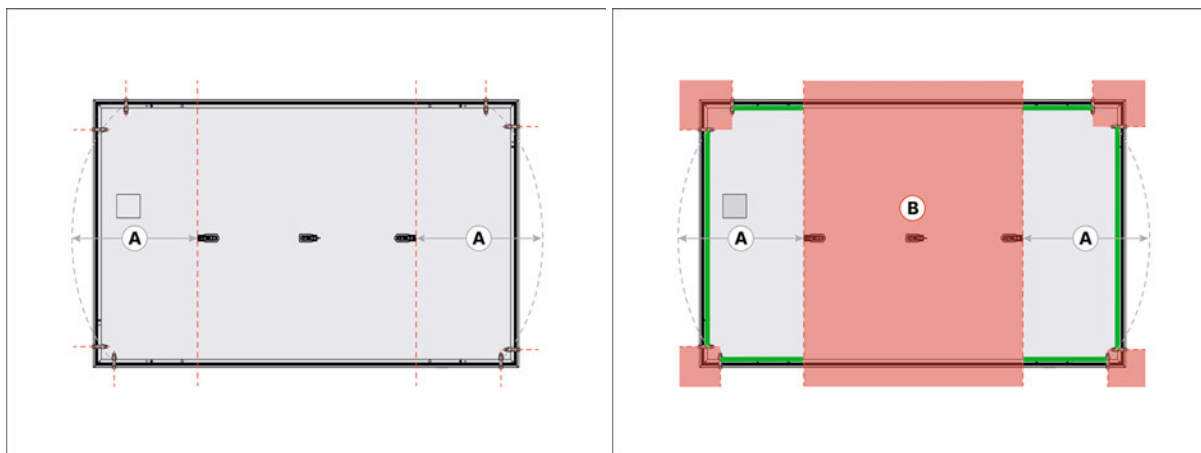


## First Clip Placement

The first DC Wire Clip must land within 24 in. (600 mm) of the junction box, toward the narrower edge of the panel and avoiding the corners.

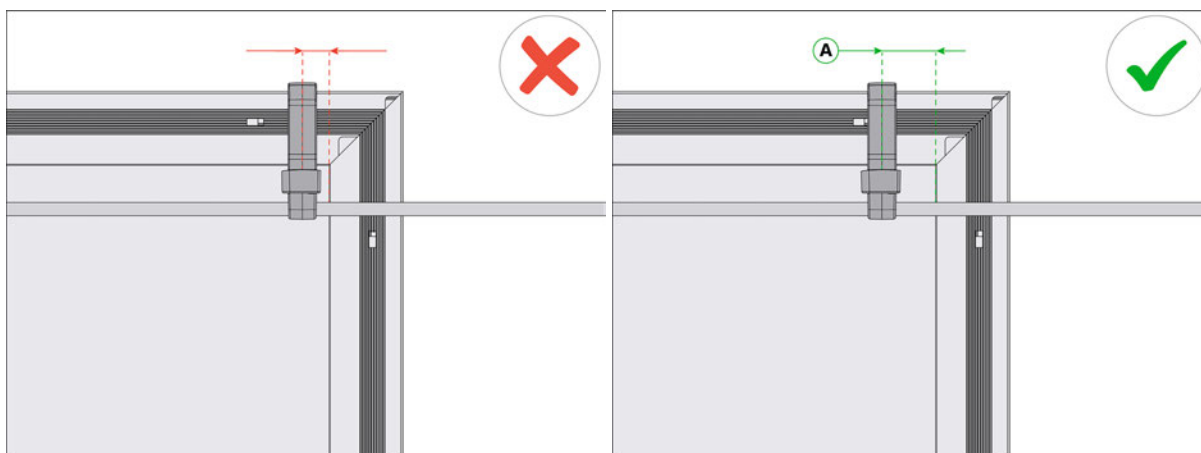


# INSTALLATION

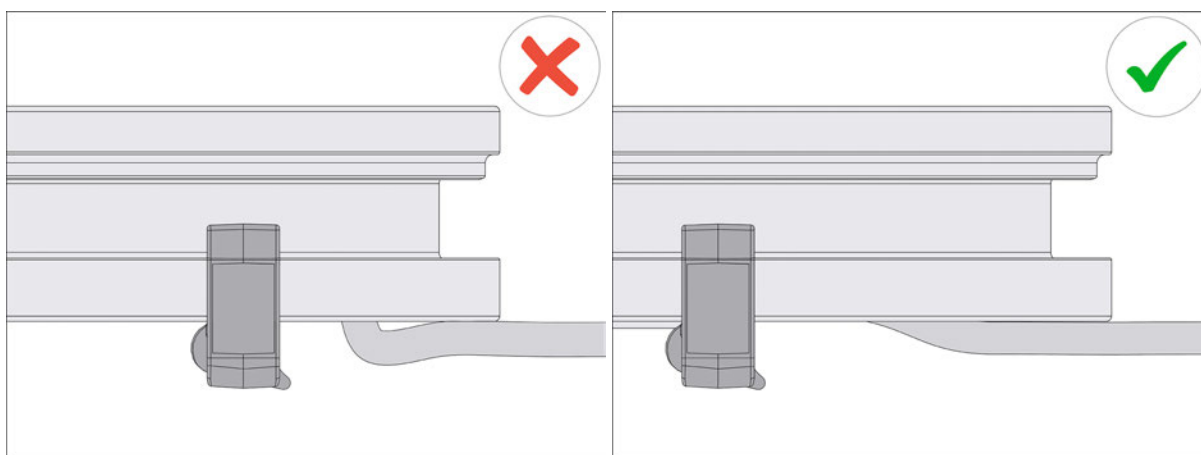


- (A) - 24 in. (600 mm) radius from junction box
- (B) - Unacceptable area for first DC Wire Clip

The minimum distance (A) between a DC Wire Clip and the module corner is 2 in. when using the back clip and crossing the module frame.

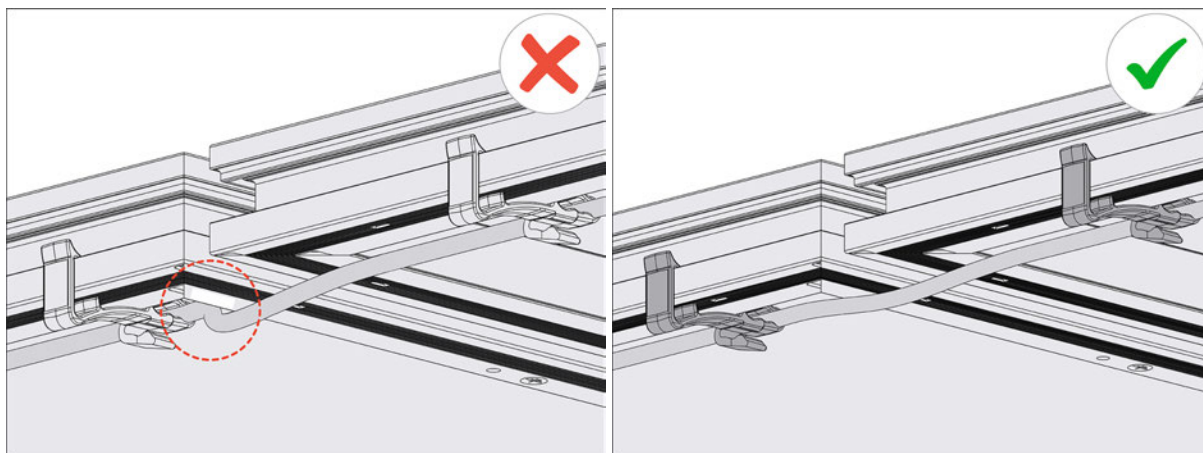


When a DC Wire Clip is too close to the module corner, it creates an incorrect bend in the wire.

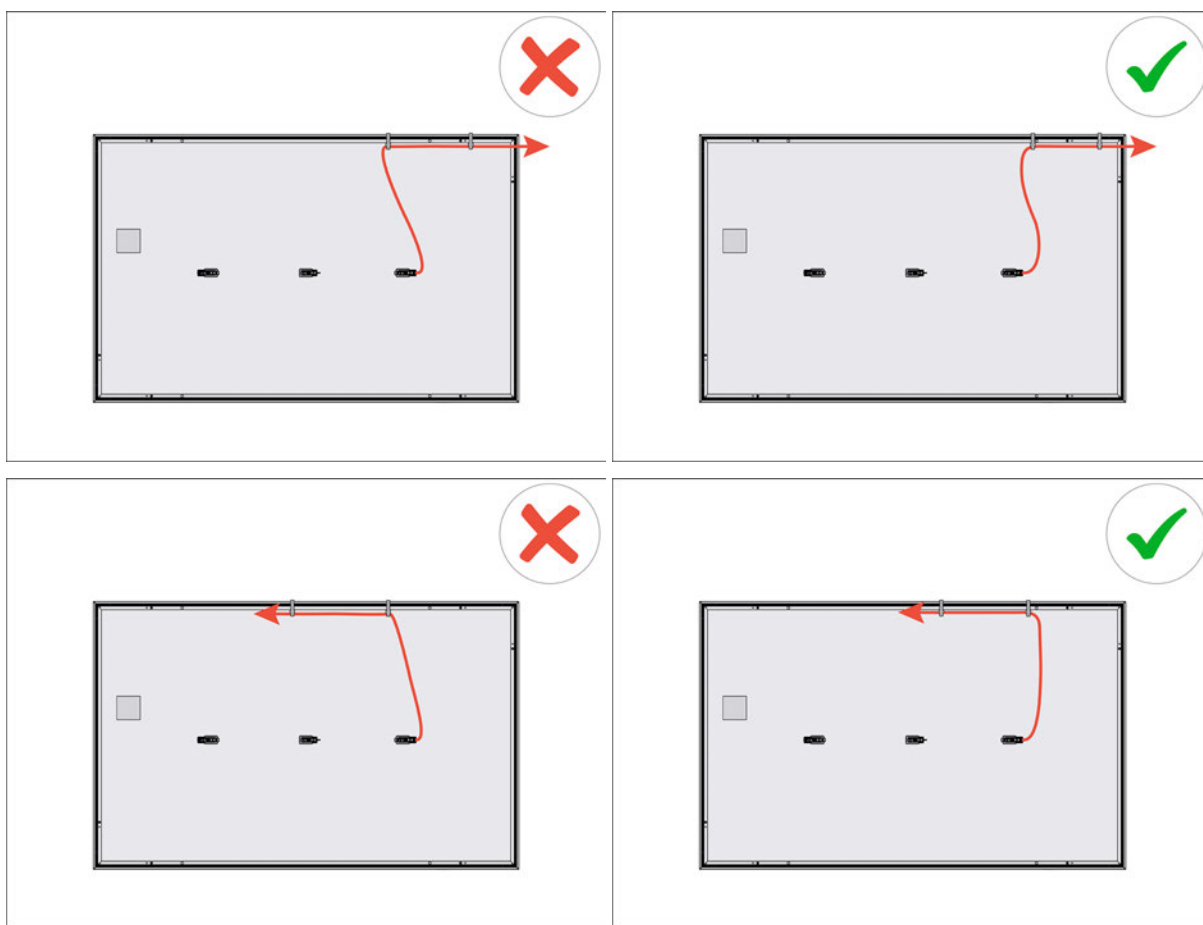




## INSTALLATION



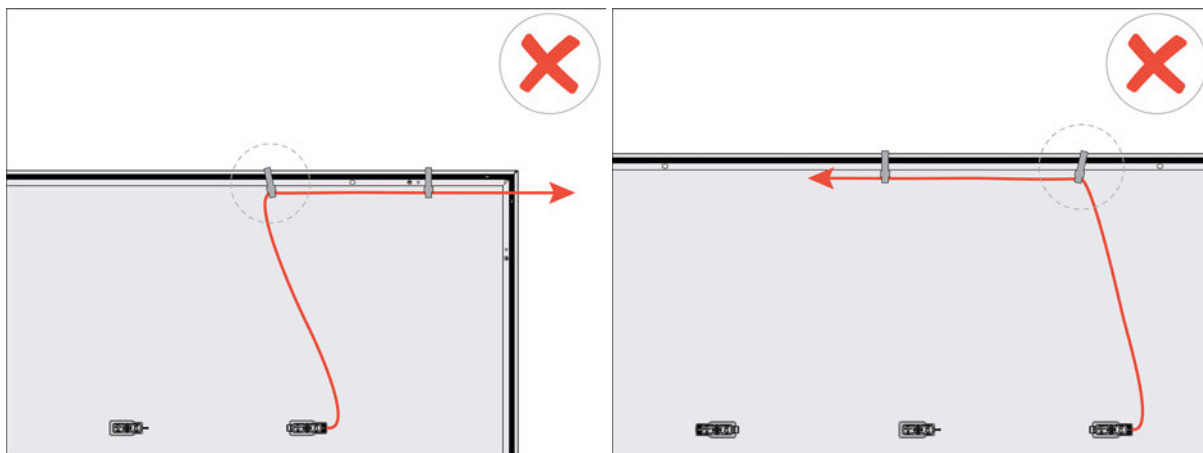
The first DC Wire Clip must not land between the junction boxes on the long side of the module.



Avoid pulling wires so tight that clips bend or rotate out of position.

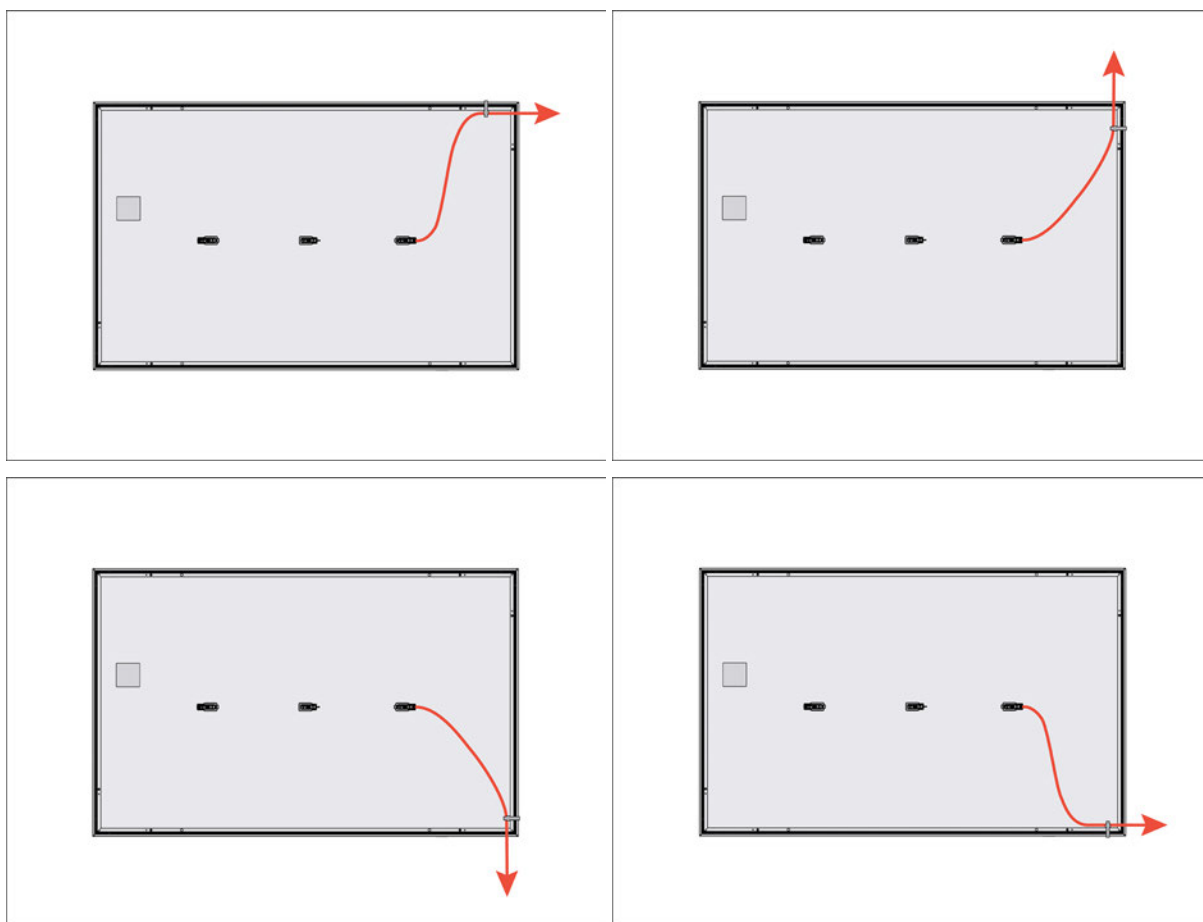


# INSTALLATION



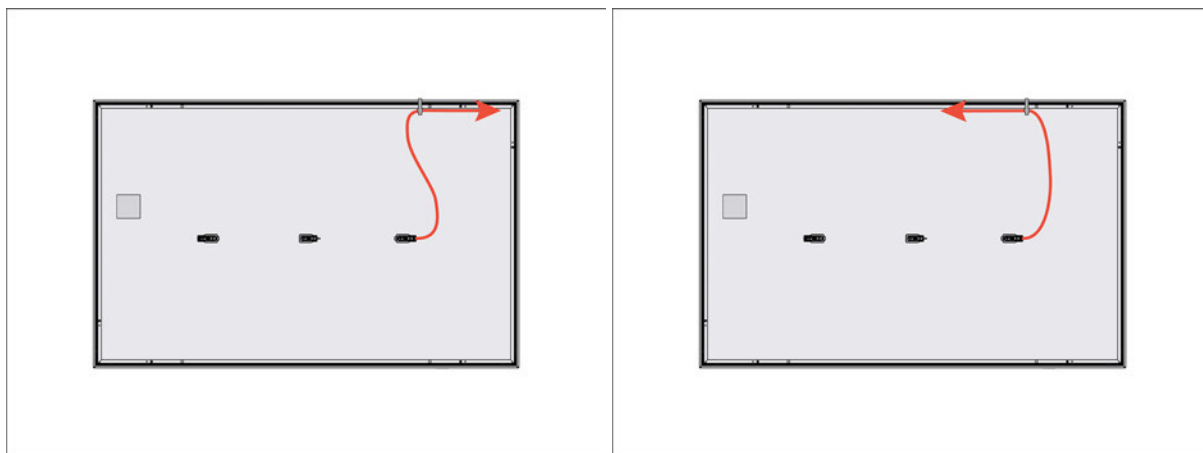
## Clip Placement Examples

Manage the wires using DC Wire Clips according to bend radius and clip spacing rules. Possible placements for the first DC Wire Clip include the following:



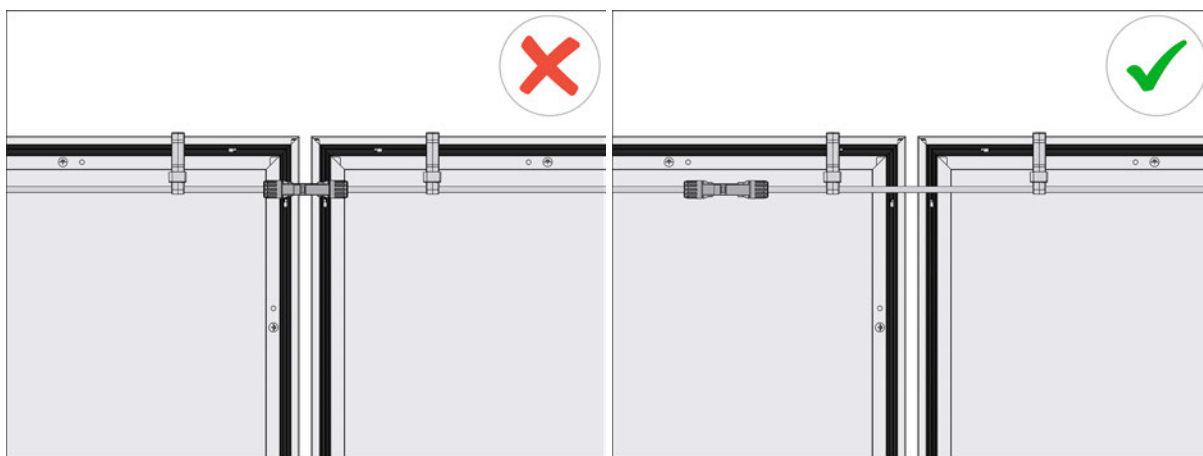


# INSTALLATION



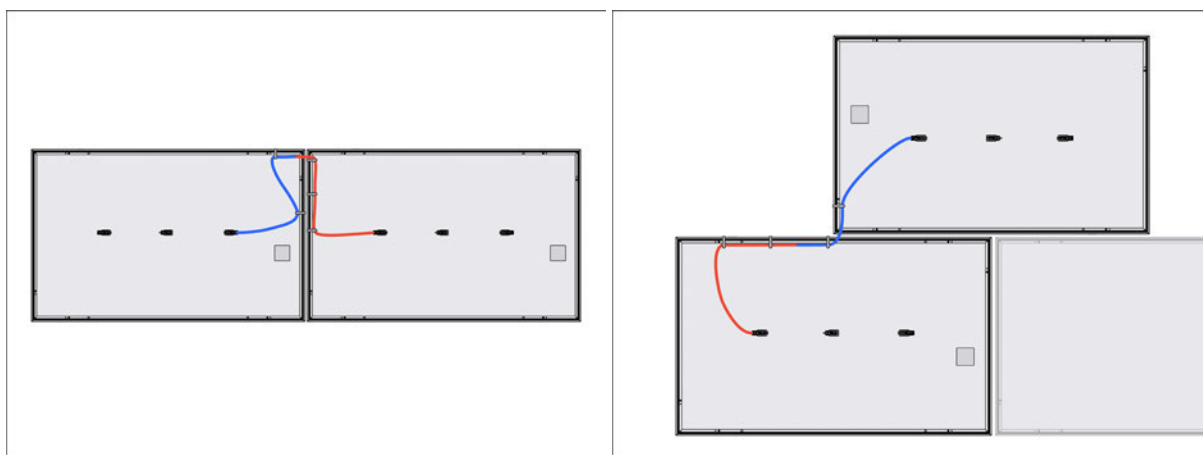
## MC4 placement

Connectors must not be placed in the gap between modules. Secure the connectors on either side of the module gap using a DC Wire Clip.



## Connections

Place each panel during installation so that the adjacent positive and negative leads comply with bend radius and wire clip placement rules. Rotate the panels when connecting to the next row to minimize up-roof/down-roof connections.



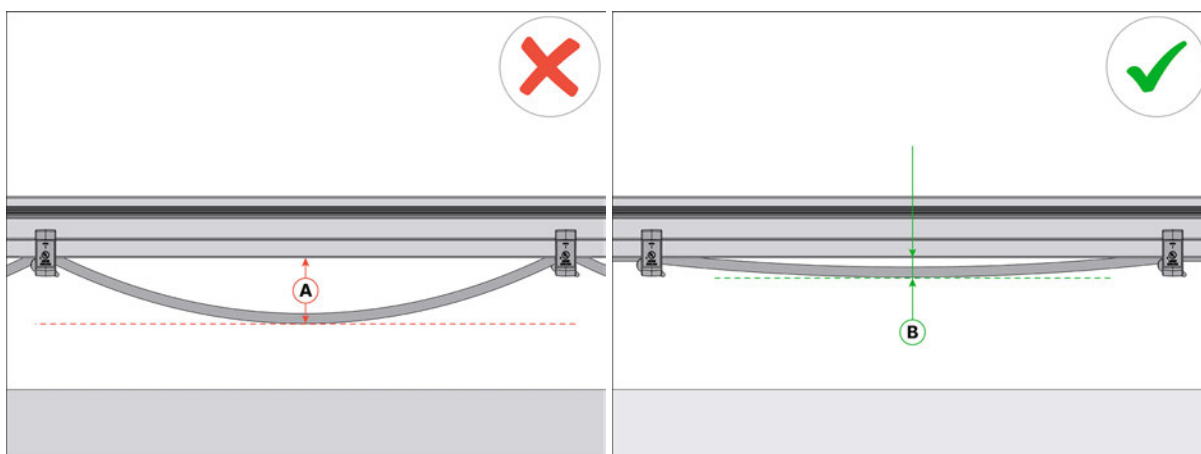


# INSTALLATION



## Managing Hanging Wires

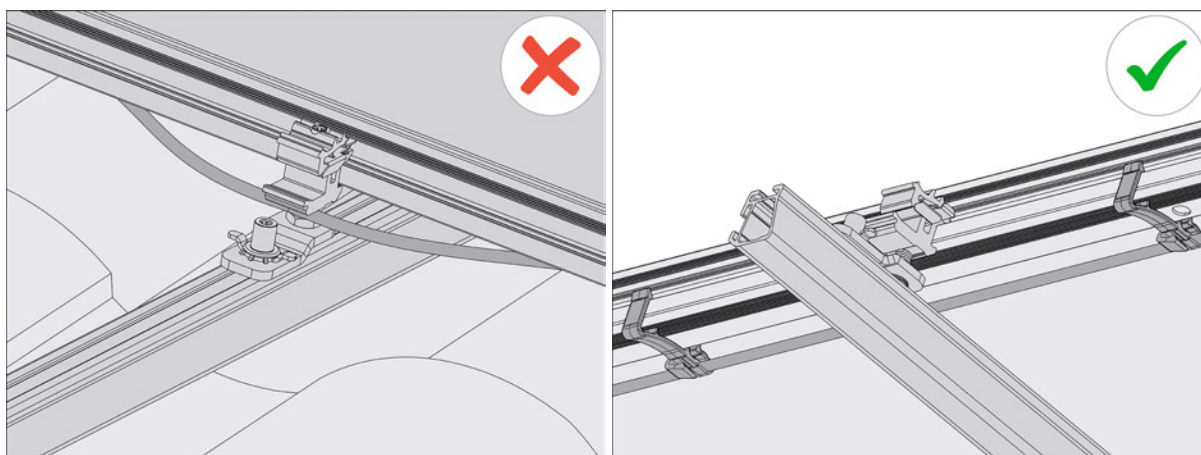
Ensure that wires do not sag more than 1 in. from the module frame between wire clips.



- (A) - Excessive sag between DC Wire Clips
- (B) - Correct installation

## Wire Management Around Hardware

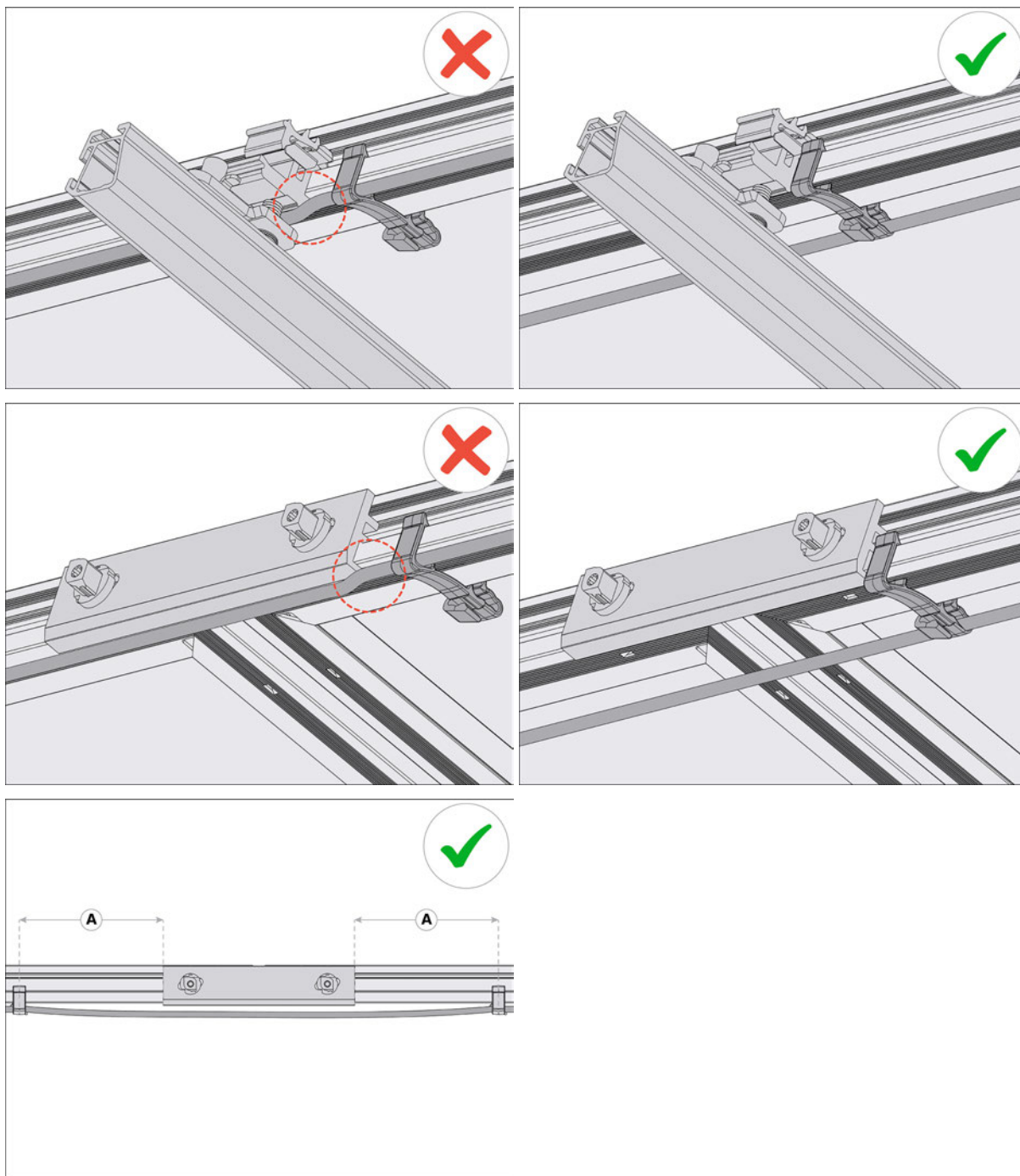
Use the back clip of the DC Wire Clip instead of routing wires around mounting hardware.



Use the back clip of the DC Wire Clip or adequate spacing to prevent PV wires from touching the mounting hardware, which may cause abrasion of the wires.



## INSTALLATION



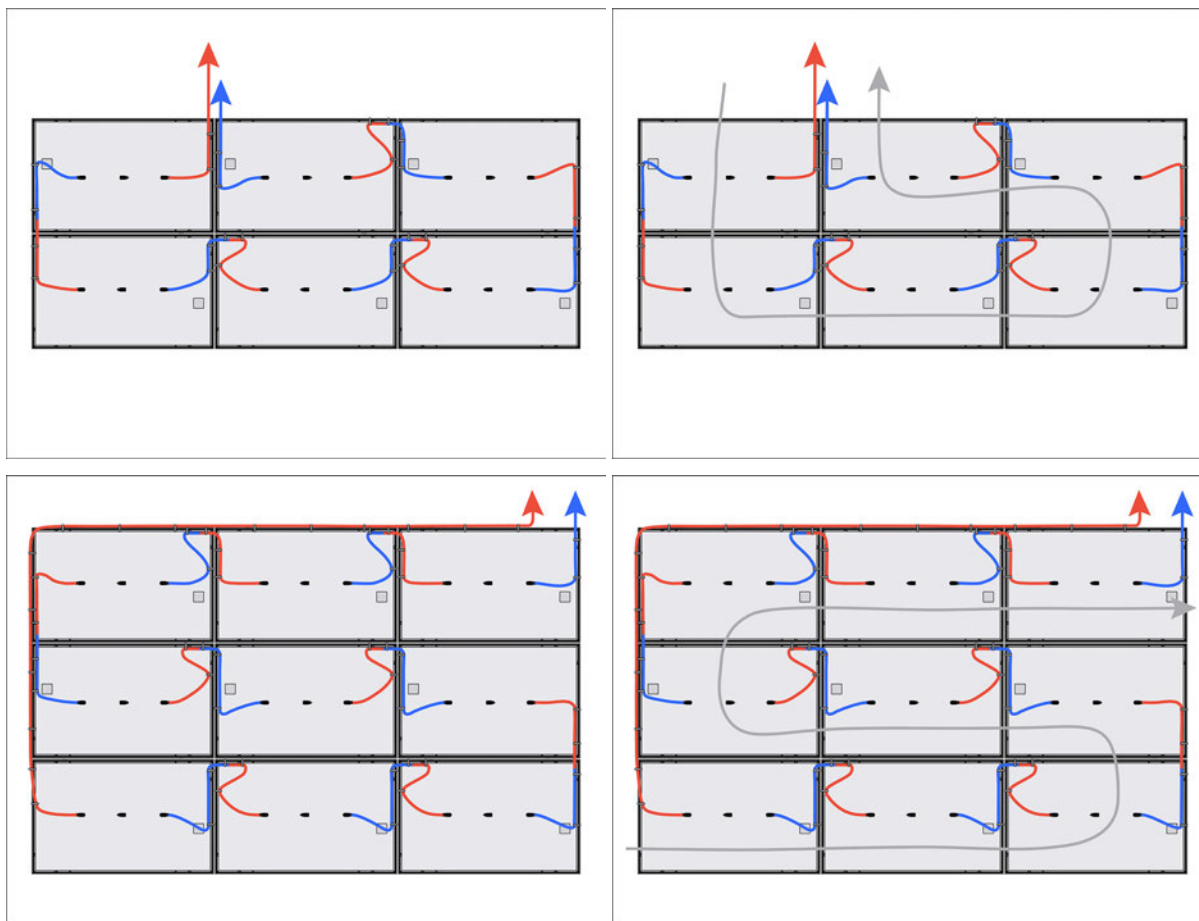
- (A) - Clips must be at least 4 in. from the Interlock when wires are in the front basket.

### Array Examples

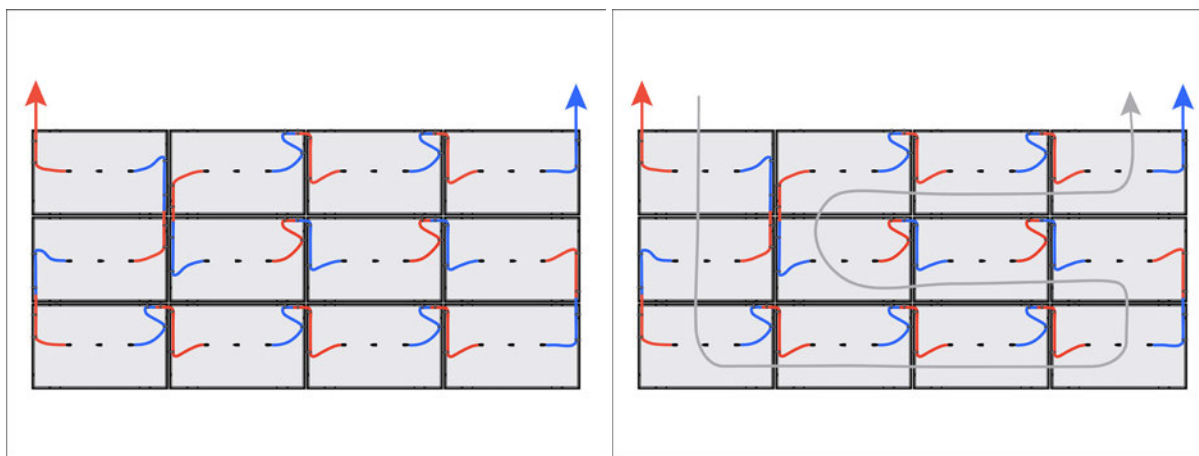
An S-shaped stringing path makes the most of side to side connections for ideal wire management.



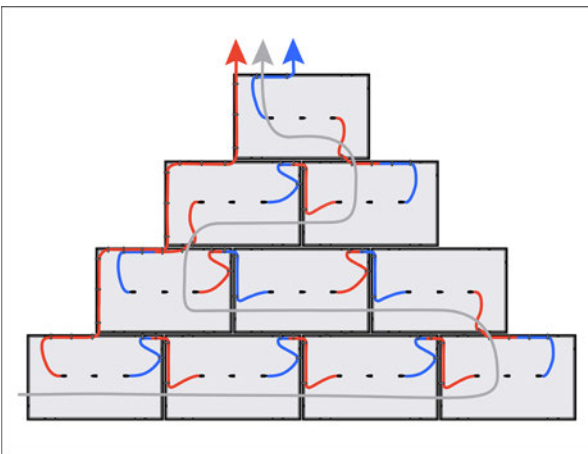
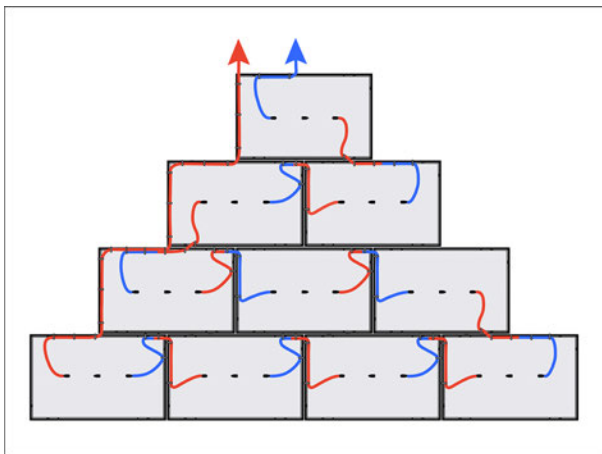
# INSTALLATION



Horizontal and vertical wiring connections can be combined to achieve the desired layout.

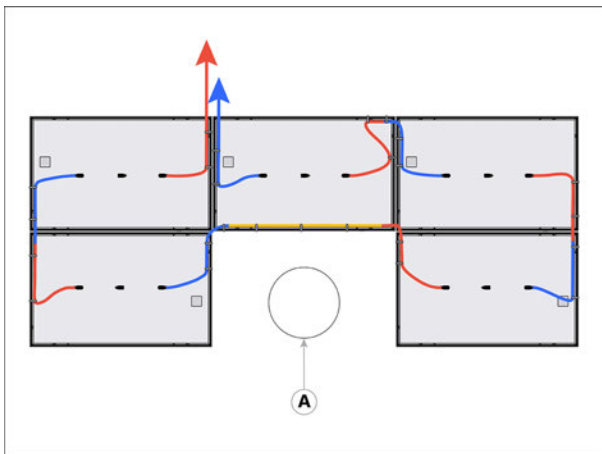


Pyramid arrays can also be optimized for side to side connections.

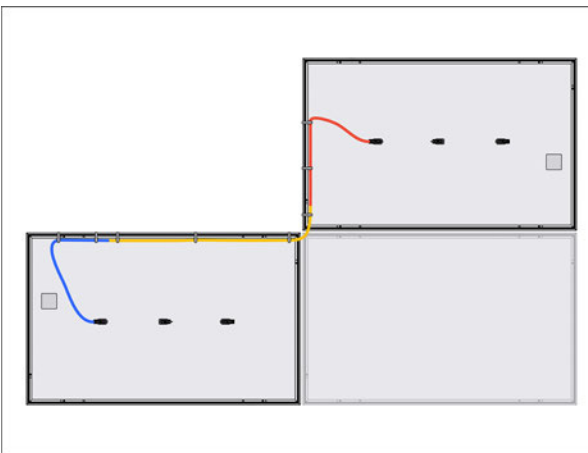
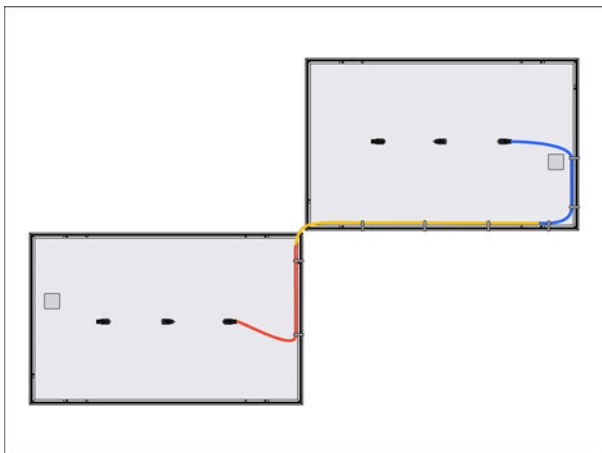


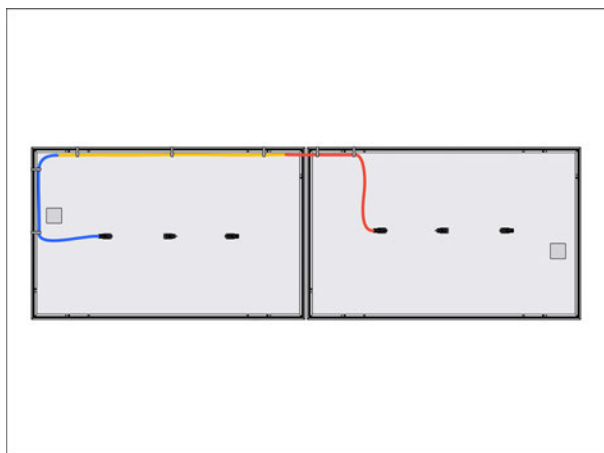
## Jumpers/Obstructions

To make connections around obstructions or in configurations where the wires cannot reach the next panel, use a jumper and manage the wires according to bend radius and clip placement rules. Ensure that MC4 connectors are not exposed in the gap between panels.



- (A) - Roof obstruction with a jumper connecting the panels on either side



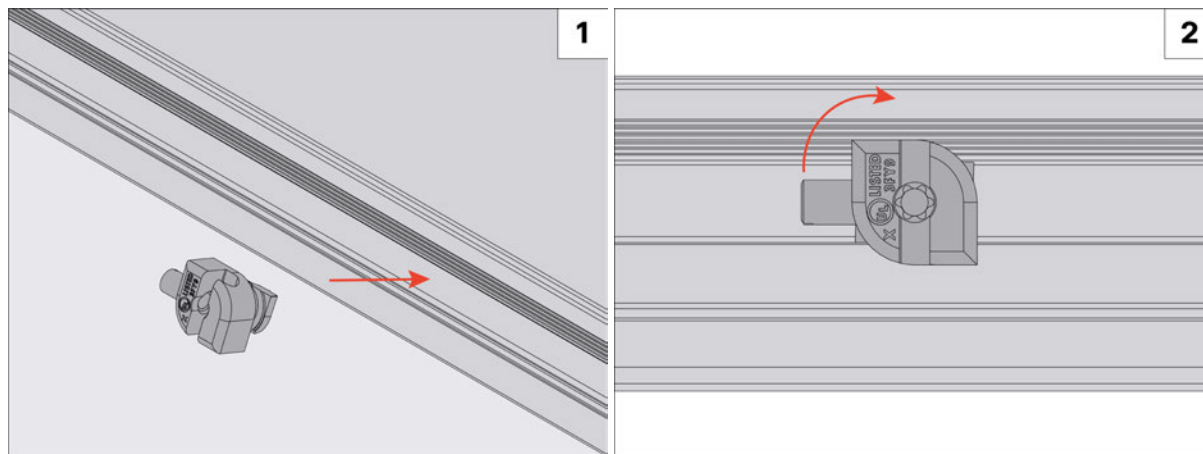


## Grounding the Array

### 1. Install the Ground Lockit.

The Ground Lockit provides a single point of connection for the equipment grounding conductor (EGC) from the array to the grounding electrode conductor (GEC.) The Ground Lockit must be placed on the module frame where the DC wiring meets the array. This must be repeated for each sub-array.

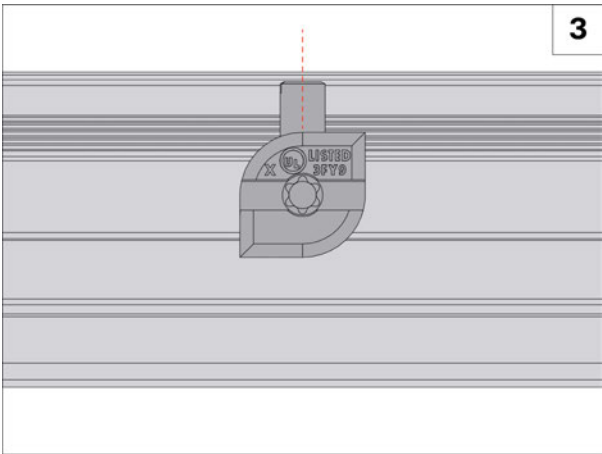
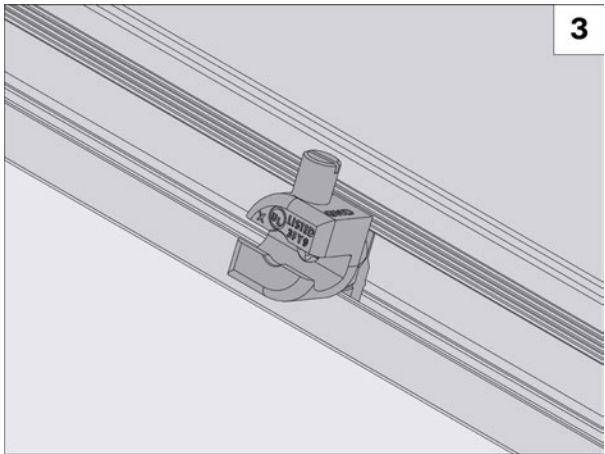
Insert a Ground Lockit into the Tesla Groove with the set screw pointing left. Rotate the Ground Lockit into place with a 90° clockwise turn.



- (1) - Ground Lockit with the set screw pointing left
- (2) - Ground Lockit in the groove of the PV module



# INSTALLATION



- (3) - Installed and rotated Ground Lockit



**NOTE:** The set screw must be pointing straight up.

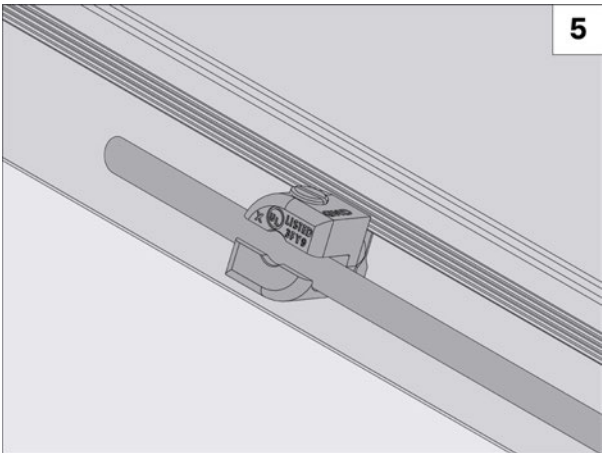
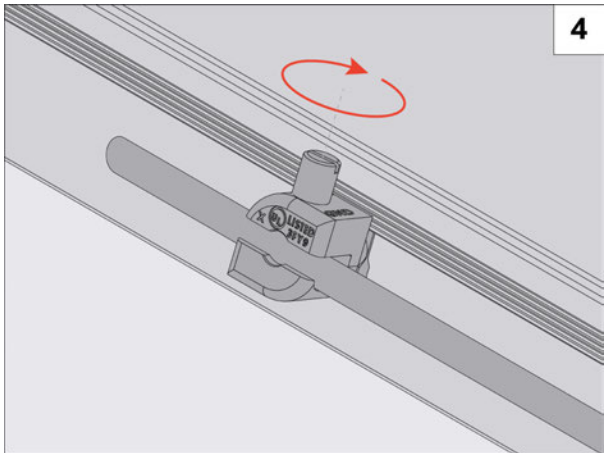


**NOTE:** Use of the following hardware is required to provide a reliable grounding connection to the module frame:

| Module |              | Grounding Device   |               |
|--------|--------------|--------------------|---------------|
| All    | Manufacturer | Type               | Torque Rating |
|        | Tesla, Inc.  | 850-1172, 850-1511 | N/A           |
|        | File E346892 |                    |               |

## 2. Insert the Ground Wire.

Insert the ground wire into the ground wire retention slot. Ensure that excess ground wire is not sticking out of the Ground Lockit.



- (4) - Ground Lockit with inserted ground wire
- (5) - Fully installed Ground Lockit

Torque the set screw based on the ground wire size:

| Cat. No. | Conductor Material | Conductor Size | Tightening Torque |
|----------|--------------------|----------------|-------------------|
| 850-1511 | Copper, solid      | 14 - 10 AWG    | 40 in-lbf         |



# INSTALLATION

| Cat. No. | Conductor Material | Conductor Size | Tightening Torque |
|----------|--------------------|----------------|-------------------|
|          |                    | 8 AWG          | 45 in-lbf         |
|          |                    | 6 AWG          | 50 in-lbf         |
|          |                    | 4 AWG          | 55 in-lbf         |

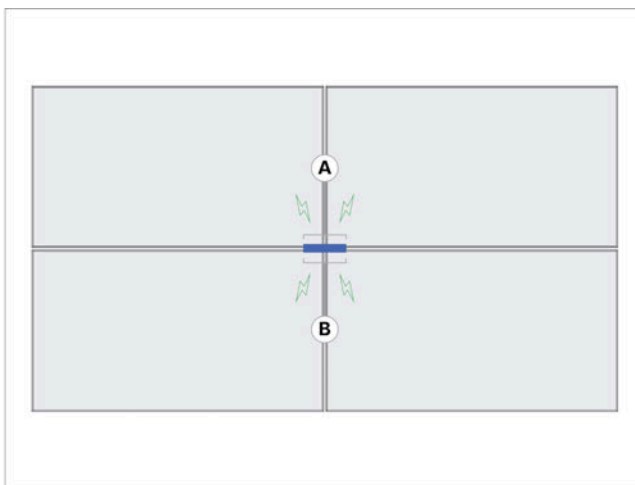
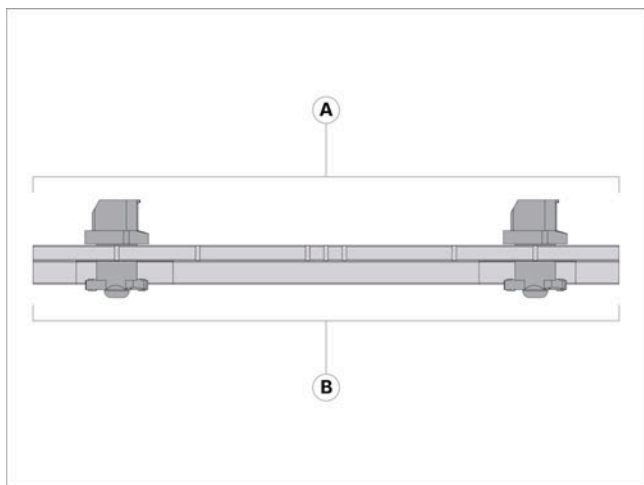
Refer to [Appendix A: Grounding and Bonding on page 65](#).



## APPENDIX A: GROUNDING AND BONDING

### Interlock Bonding

The Interlock bonds modules on all four sides and across the Interlock plate to create a redundantly-bonded array where every module is structurally and electrically bonded to the surrounding modules.



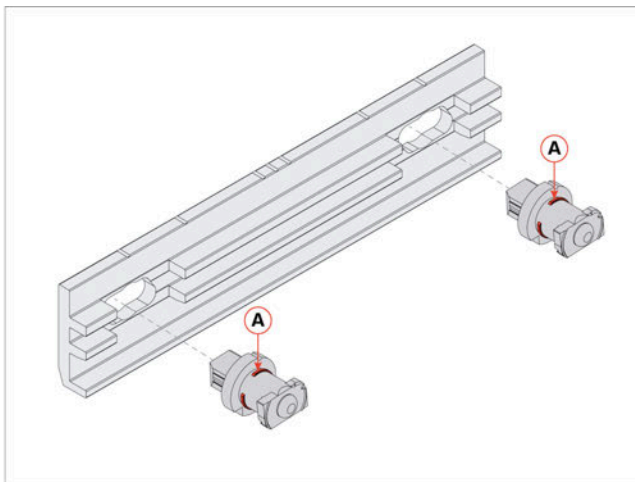
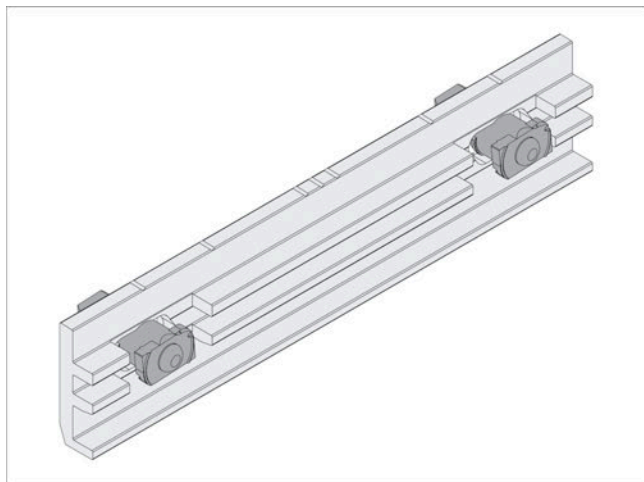
- (A) - Tongue side of the Interlock
- (B) - Key side of the Interlock
- ⚡ Bond path
- — Interlock



## APPENDIX A: GROUNDING AND BONDING

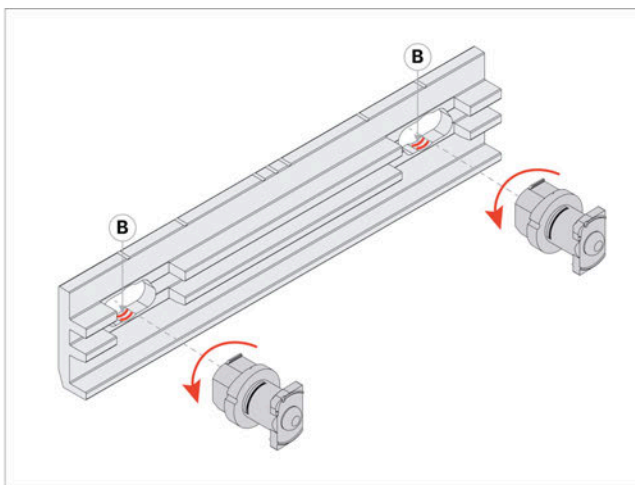
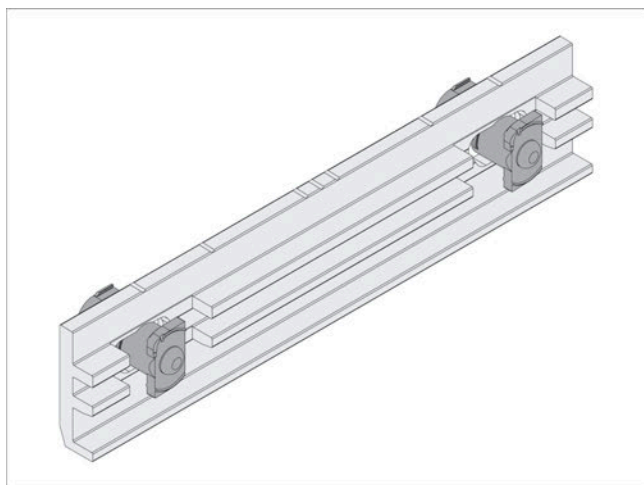
### Interlock Lockit to Interlock Bonding

The rotating fastener attached to the Interlock plate, called the Lockit or Interlock Lockit, has two cutting teeth on the shaft that cut into the Interlock plate when the Lockit is tightened during normal installation, resulting in a robust and UL-certified bonding path. The Interlock may be re-installed up to 15 times.



- Lockit (A) in open position:

Lockit in locked position cuts into Interlock plate:



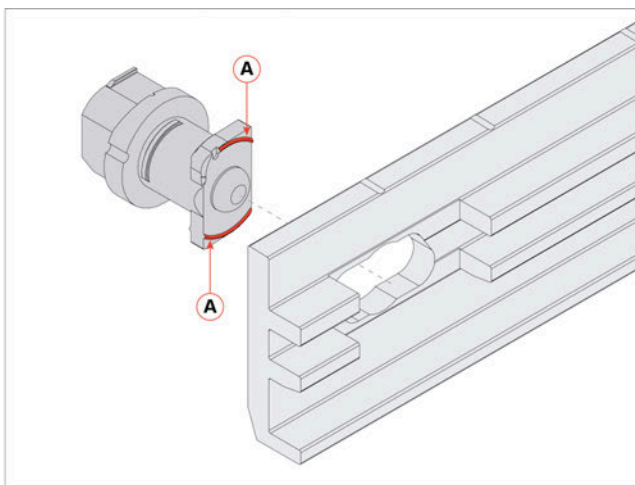
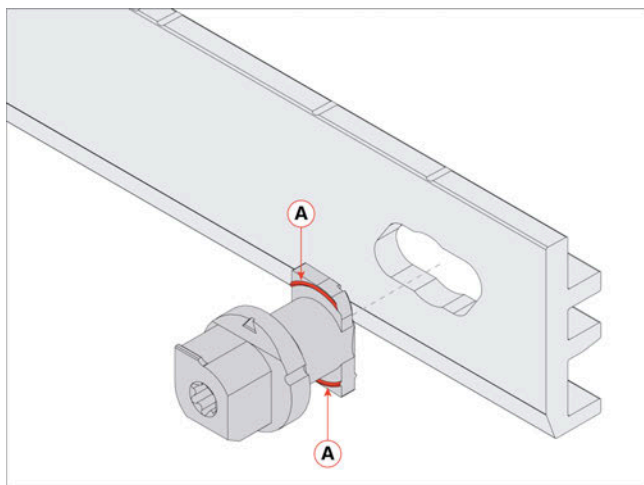
- Lockit in locked position cuts into Interlock plate (B)

### Interlock Bonding to Module Frame

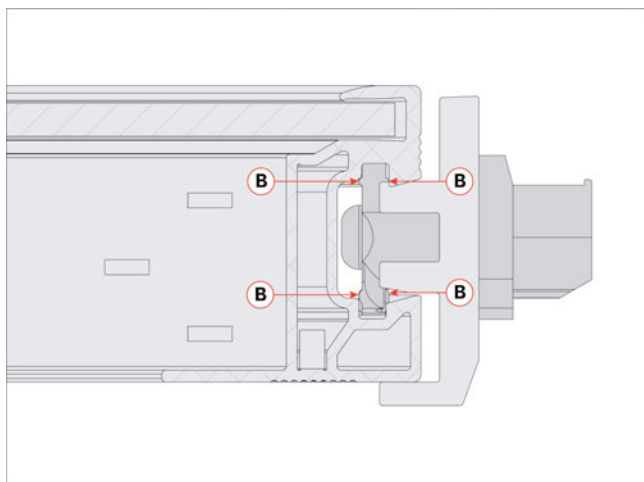
Forced interference during the rotation of the Interlock Lockit causes the teeth to cut through the coating on the module frame, resulting in a robust and UL-certified bonding path. The Key side of the Interlock Lockit bonds the down-roof edge of modules, as shown below:



## APPENDIX A: GROUNDING AND BONDING

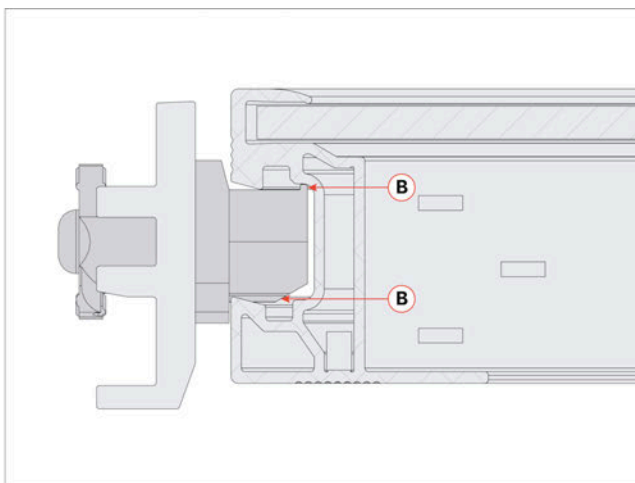
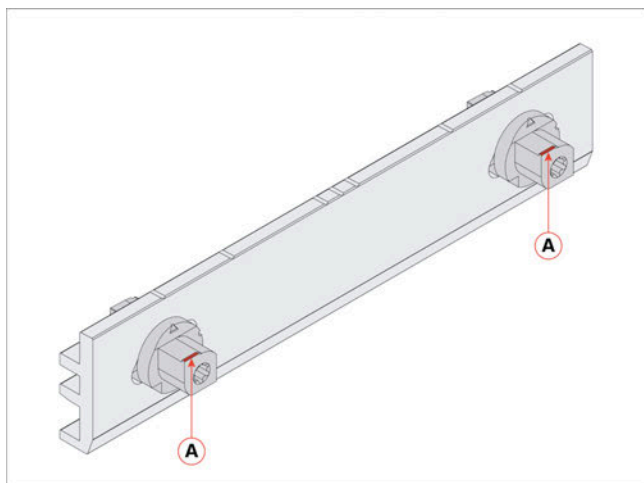


- (A) - Teeth on Interlock Lockit



- (B) - Forced interference bonding with module frame

The Tongue side of the Interlock Lockit bonds modules on the up-roof side in a similar manner, as shown below:



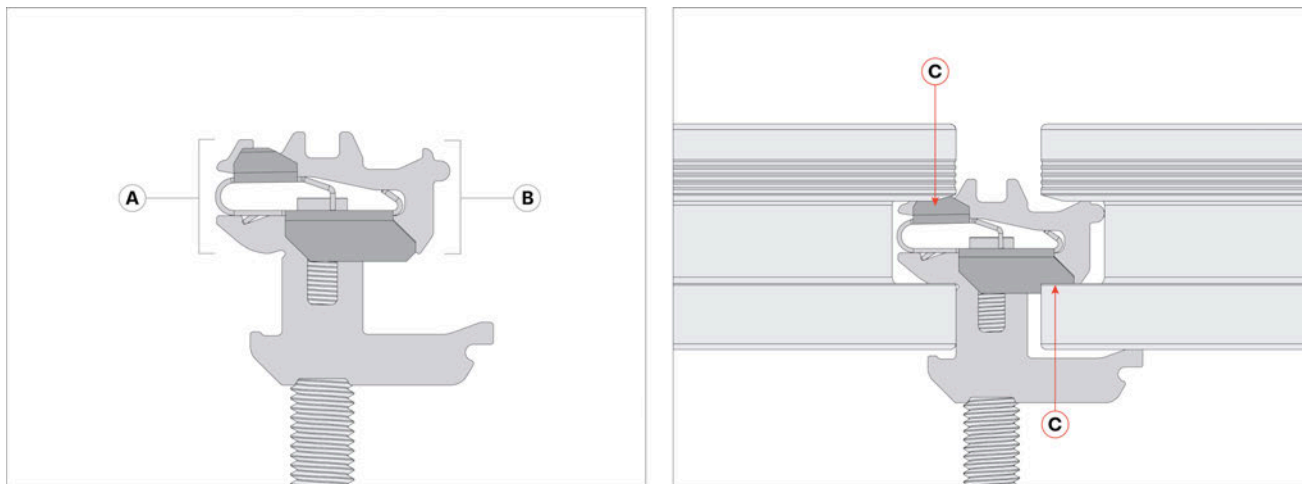
- (A) - Teeth on Interlock Lockit
- (B) - Forced interference bonding with module frame



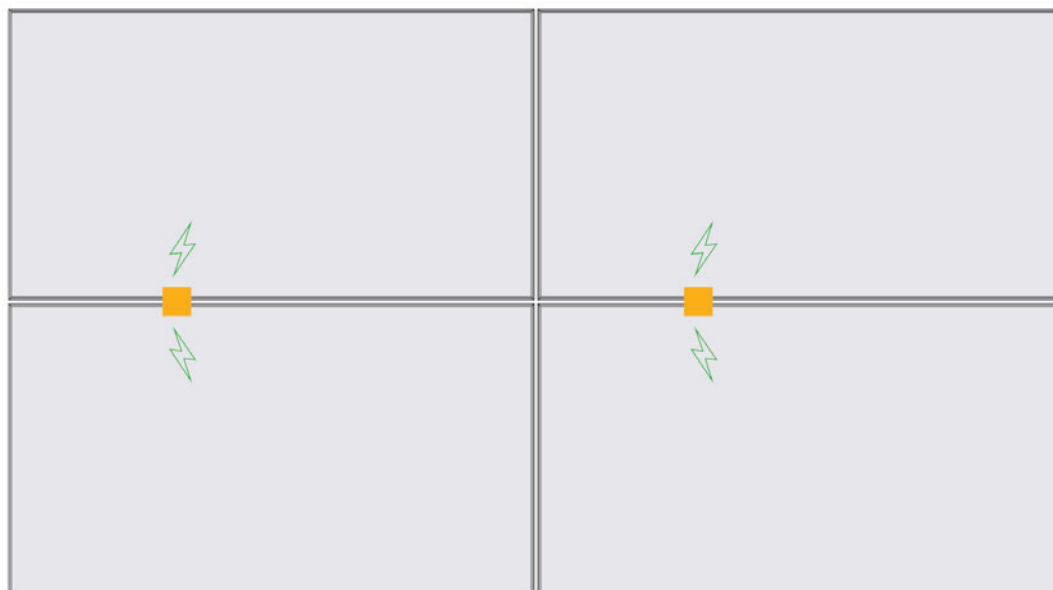
## APPENDIX A: GROUNDING AND BONDING

### Key & Tongue Side Bonding of the Rockit

The Rockit has a stainless-steel spring clip that bonds to the adjacent module frame on both Key and Tongue sides. A module can be pulled out to the edge of the lip and still be correctly installed, allowing for small variations in module sizes or module alignment.



- (A) - Key side of Rockit
- (B) - Tongue side of Rockit
- (C) - Bond location



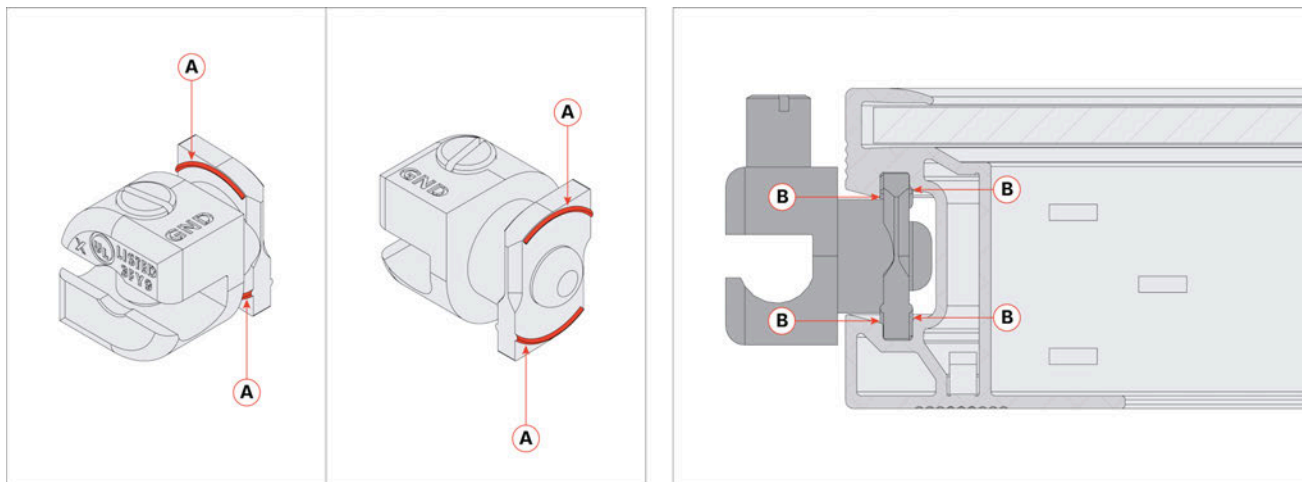
-  Bond path
-  Rockit



## APPENDIX A: GROUNDING AND BONDING

### Ground Lockit

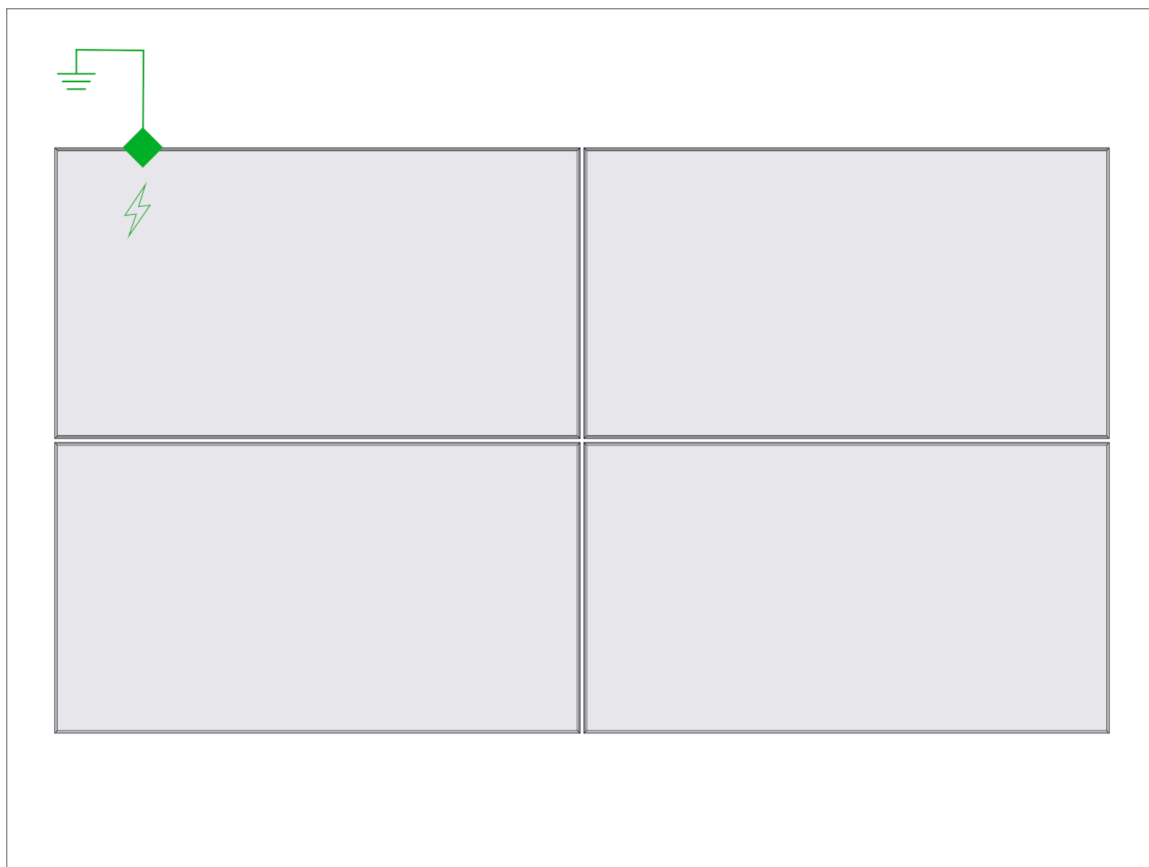
The Ground Lockit bonds to the modules in the same way as the Interlock with biting teeth that cause forced interference during rotation. The teeth cut through the coating on the module frame, resulting in a robust and UL-certified bonding path.



- (A) - Teeth on Ground Lockit
- (B) - Forced interference bonding with module frame



## APPENDIX A: GROUNDING AND BONDING



-  Bond path
-  Ground Lockit
-  Equipment grounding conductor (EGC)
-  Earth ground

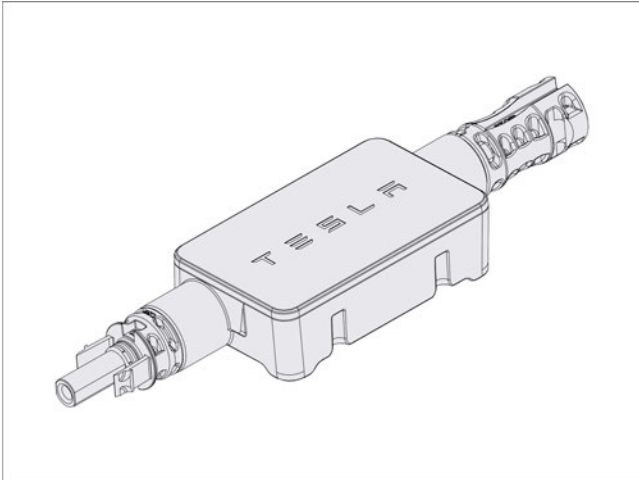


## APPENDIX B: WIRE MANAGEMENT RECOMMENDATIONS

### Installing Mid-Circuit Interrupters (MCIs) in PV Arrays

The Tesla Mid-Circuit Interrupter (MCI) is used within PV strings and arrays to meet the rapid shutdown requirements of NEC Article 690.12.

#### MCI-2



#### MCI Locations

The quantity and placement of MCIs necessary to meet rapid shutdown requirements in NEC Article 690.12 (B) is governed by the UL 3741 (PV Hazard Control System or PVHCS) listing applicable to various array types. Always refer to the applicable PVHCS datasheets and references included in the addendum for detailed instructions to ensure adequate compliance and safe operation.

**WARNING:** It is critical that the minimum number of required MCIs is installed. Without the appropriate number of MCIs, the MCIs may not function as intended, which could lead to equipment damage and risk of electrical shock.

**NOTE:** MCIs are not required if the system does not need to comply with rapid shutdown requirements (NEC 690.12).

#### Installation Best Practices

- Do not store MCIs in environments with moisture or dirt prior to installation. Improper storage can lead to corrosion on the connector pins.
- Install the Tesla MCI in line with the PV modules using standard Staubli MC4 connectors. Incompatible connectors can lead to system failures.
- Ensure that the MCI is a minimum of ½ in. from the glass or backside of a PV module. This prevents overheating of the power electronics.
- Always secure the MCI with wire clips as specified. NEC 690.31(C)(1)(b) specifies that there must be a wire clip every 24 in. (600 mm). Wire clips must be at least 2 in. (50 mm) but not more than 6 in. (150 mm) from the connectors.
- Ensure that no more than 5 MCIs are connected per PV string.

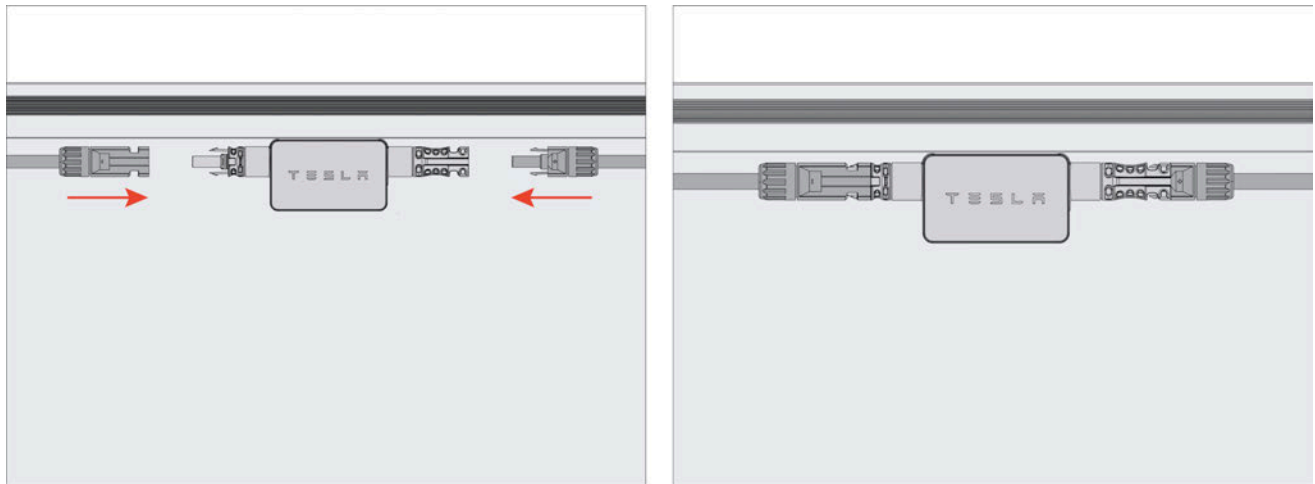


## APPENDIX B: WIRE MANAGEMENT RECOMMENDATIONS

- Ensure that the total DC circuit length, from (+) MPPT terminal to (-) MPPT terminal (including module wire leads, jumper wires, and all wiring within the array boundary for any individual string) does not exceed 525 ft (160 m) for single strings or 394 ft (120 m) for parallel strings.
  - The total DC circuit length refers to the entire round trip wire length from the inverter to the roof, then back to the inverter.
  - Ensure that the parallel strings are the same length or as close in length as possible. If the parallel strings are different lengths, it is likely that the MCIs will not function properly. This likelihood increases with greater difference in parallel string lengths.
- Keep a completed string diagram indicating the layout of the array and the placement of each MCI (either a paper copy, electronic copy available in the field, or both).

### Installing MCIs

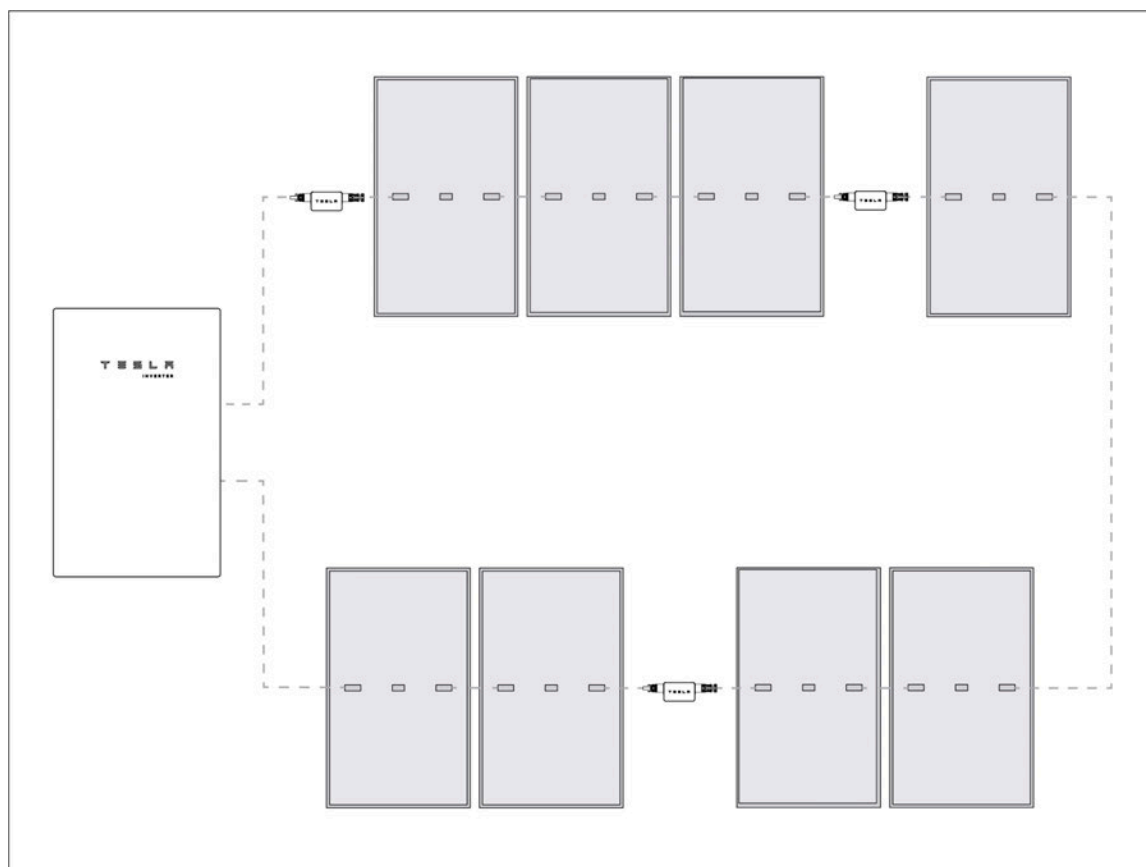
1. Connect the positive and negative leads of the MCI to the corresponding positive / negative MC4 terminals of the PV modules.



#### MCIs Installed in Line with PV Modules



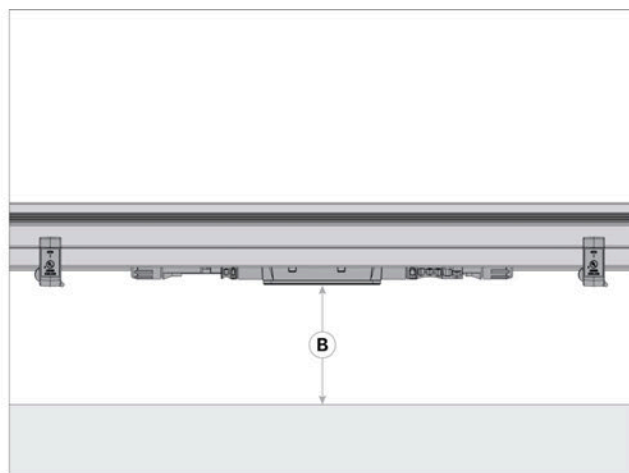
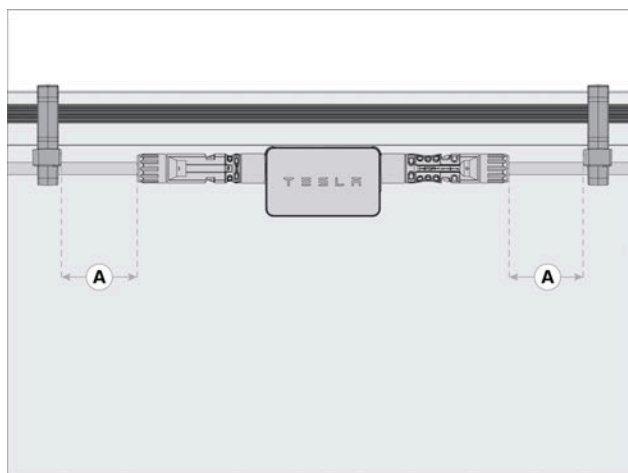
## APPENDIX B: WIRE MANAGEMENT RECOMMENDATIONS



### 2. Attach the MCI under the module frame.

- To attach the MCI using DC Wire Clips or Home Run Wire Clips, install two clips to the module frame and clip both ends of the MCI leads, then slot the MCI underneath the metal frame.

#### MCI-2 Attached with Wire Clips



- (A) - Minimum distance from clips
- (B) - Minimum distance from roof



**CAUTION: Do not twist the MC4 connectors on MCI-2.** Twisting the connectors damages the electrical contacts inside, likely resulting in MCI failure.



## APPENDIX B: WIRE MANAGEMENT RECOMMENDATIONS



**NOTE:** For MCI-2, place the wire clips at least 2 in. (50 mm) but not more than 6 in. (150 mm) from the connectors.