

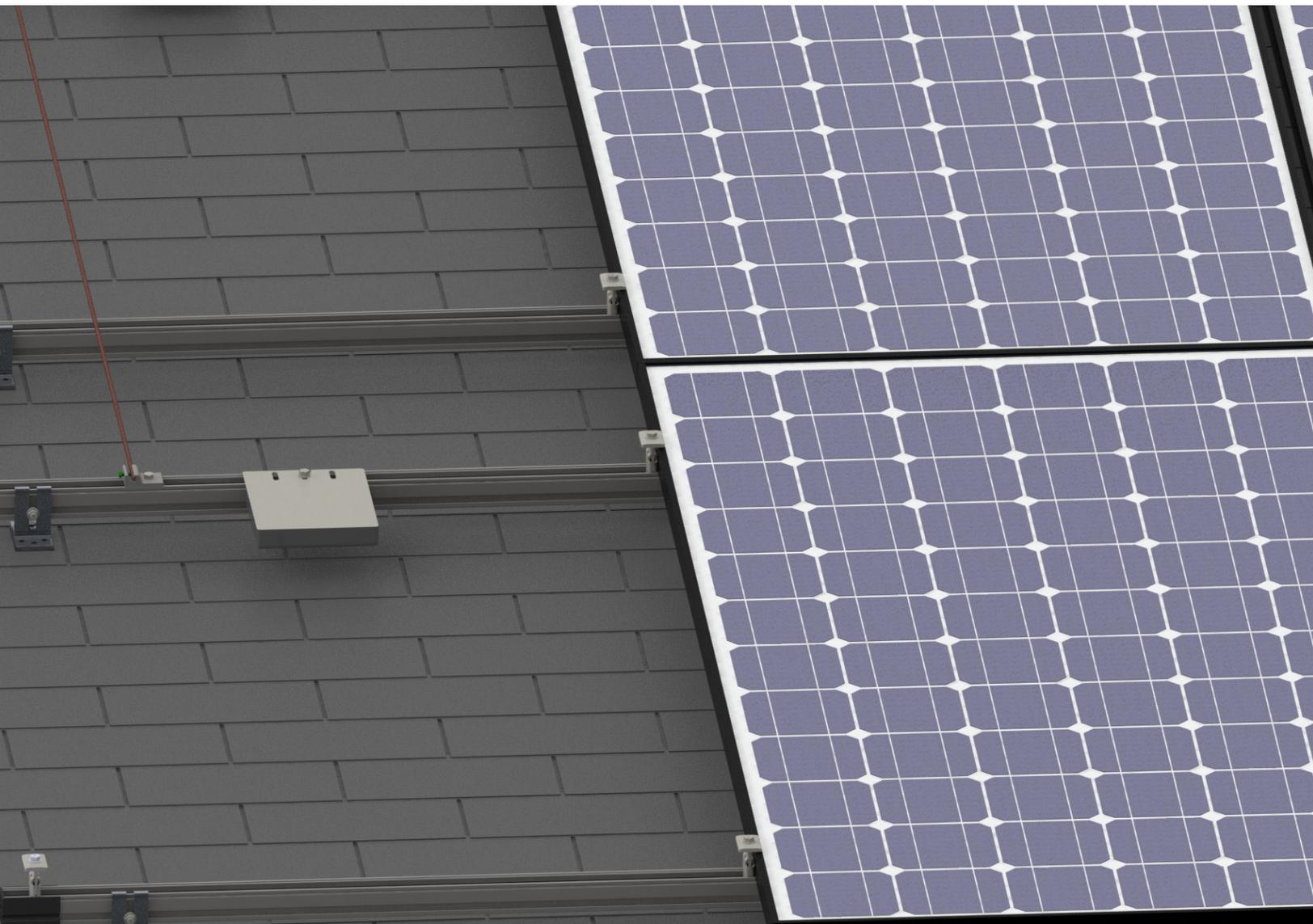


Connecting Strength

CrossRail

UL 3741 PV Hazard Control

⊖ **INSTALLATION ADDENDUM**





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Engineering strength is at our core

With sophisticated product innovations and a deep customer focus, K2 Systems is the engineering leader for all your mounting system needs. We are a market leader with more than 32 GW installed worldwide.

We offer proven product solutions and innovative designs. Wind tunnel testing along with advanced structural and electrical validation to facilitate permitting, design and installation. Our designs result in cost competitive racking systems with dedicated support that will position you to win more projects.

We partner with our customers and suppliers for the long-term. High quality materials and cutting edge designs provide a durable, yet functional system. Our product line is comprised of a few, coordinated components that lower the cost of materials, and simplify installation, saving you time and money. All backed by German engineering, a long track record of quality and a company that is here to stay.

Thank you for choosing K2 Systems for your Solar PV Project.

Quality tested - several certifications

K2 Systems stands for secure connections, highest quality and precision. Our customers and business partners have known that for a long time. Independent institutes have tested, confirmed and certified our capabilities and components.

Please find our quality and product certificates under:
<https://k2-systems.com/en-us/company/quality-management/>



Disclaimer

This manual describes proper installation procedures and provides the necessary standards required for product reliability. Warranty details are available at k2-systems.com/en-us. All installers must thoroughly read this manual and have a clear understanding of the installation procedures prior to installation. Failure to follow these guidelines may result in property damage, bodily injury or even death

INSTALLER'S RESPONSIBILITY

- Ensure safe installation of all electrical aspects of the array. All electrical installation and procedures should be conducted by a licensed and bonded electrician or solar contractor. Routine maintenance of a module or panel shall not involve breaking or disturbing the bonding path of the system. All work must comply with national, state and local installation procedures, product and safety standards.
- Comply with all applicable local or national building and fire codes, including any that may supersede this manual.
- Ensure all products are appropriate for the installation, environment, and array under the site's loading conditions.
- Use only K2 Systems parts or parts recommended by K2 Systems; substituting parts may void any applicable warranty.
- If needed, use K2 System's design tool, Base, to obtain accurate system design prior to installation.
- Ensure provided information is accurate. Issues resulting from inaccurate information are the installer's responsibility.
- Ensure bare copper grounding wire does not contact aluminum and zinc-plated steel components, to prevent risk of galvanic corrosion.
- Refer to components list and respective manufacturers for best practices on inspection frequency. K2 Systems recommends annual inspection. If loose components or loose fasteners are found during periodic inspection, re-tighten immediately. Any components showing signs of corrosion or damage that compromise safety shall be replaced immediately.
- Provide an appropriate method of direct-to-earth grounding according to the latest edition of the National Electrical Code, including NEC 250: Grounding and Bonding, and NEC 690: Solar Photovoltaic Systems.
- Disconnect AC power before servicing or removing modules, microinverters and power optimizers.
- Review module manufacturer's documentation for compatibility and compliance with warranty terms and conditions.
- Installers shall refer to the CrossRail assembly instructions for complete installation instructions.
- Review all third-party equipment installation manuals for specific instructions such as installation configurations, mounting, Clearances, compatible connectors, and rapid shutdown initiation methods.
- Ensure that the roof is in good condition prior to installing any K2 System's components.

CAUTION: Module removal may disrupt the bonding path and could introduce the risk of electric shock. If during servicing a module is required to be removed, a bonding jumper shall be installed between the adjacent modules from where the module was removed to maintain the bond path.

WARNING: To reduce the risk of injury, read all instructions.

Ratings



UL 2703 LISTED
UL 3741 LISTED



CONFORMS TO STD ANSI/UL 3741 STANDARD FOR SAFETY PHOTOVOLTAIC HAZARD CONTROL SYSTEM

Max PVHCS System Voltage: 1000V

CrossRail List of Approved PV Hazard Control Equipment or Components evaluated at 1000V Max System Voltage: (Not all listed items must be implemented in a single system to achieve compliance to UL 3741. Rather these are the items approved for use to meet the criteria outlined in this manual.)

- All Modules listed in the Approved Modules section of the CrossRail Assembly Instructions
- The CrossRail System
 - CrossRail 44-X / 44-XMAX / 48-X / 48-XL / 80, Mill / Dark (Multiple PNs)
 - MiniRail Comp 2.0 (Multiple PNs)
 - K2 Cross Clamp Set, Mill / Dark (Multiple PNs)
 - Yeti Clamp 2.0 Set (4000050-B)
- CrossRail Accessories
 - MLPE Module Frame Mount Kit (4000083)
 - CR Micro Inverter and OPT Kit (4000629-H)
 - K2 Rail Runner Set, Mill / Dark (4000770 / 4000769)
- PV Connectors (UL 6703 Listed) shall be compatible and approved for the application
- Conductors
 - PV Wire (UL 4703 Listed)
 - USE-2 Wire (UL 854 Listed)
 - RHW-2 Wire (UL 44 Listed)
 - DG Cable (UL 3003 Listed)
- Wire Clips
 - Hellermann Tyton Edge Clip Cable Ties (PNs CTT60R0HSC2, 156-02224 and 156-02226) (UL 62275 listed)
 - Heyco SunRunner Short Flange (UL 1565)
 - Heyco SunBundler XX Cable Ties (UL 62275 Listed), where xx = 8, 10 or 12
 - Heyco Edge Clips
 - Wiley Cable Clips (Models ACC-FPV, ACC-FPV180 and ACC-F90-1)
 - EZ-Solar CableLoc xx, where xx = 8 or 12
 - EZ-Solar GripClip
 - Standard Zip Ties (UL 62275 Listed)
 - HEYClip SunRunner S6404 (4000382)
 - TC Wire Management Clip (4000069)
 - K2 Dragon Clip (4000400)
- RayTray v2 Solar Wire Management System (UL 870 Listed)



- Listed Conduit (all size apply)
 - Electrical Metallic Tubing (EMT), size 3/4" or greater (UL 797 Listed)
 - Rigid Metal Conduit (RMC), size 3/4" or greater (UL 6 Listed)
 - Intermediate Metal Conduit (IMC), size 3/4" or greater (UL 1242 Listed)
 - Liquid-Tight Flexible Nonmetallic Conduit, size 3/4" or greater (UL 1660 Listed)
 - Liquid-Tight Flexible Metal Conduit, size 3/4" or greater (UL 360 Listed)
 - PVC Schedule 40 or 80, size 3/4" or greater (UL 651 Listed)
 - Bonding Bushings, size 3/4" or greater (UL 467)
 - Various Listed Conduit, Connectors and Fittings

NOTE: The CrossRail System was evaluated up to 1000 Vdc. However, per NEC 690.7, PV system DC circuits on one or two-family dwellings are limited to 600 Vdc maximum. PV system DC circuits on other types of buildings are limited to 1000 Vdc maximum. Requirements for PV arrays addressed in UL 3741 are intended for compliance with the National Electrical Code (NEC), NFPA 70, 2017 and later editions. Their requirements for controlling electrical shock hazards inside the array boundary as addressed in NEC section 690.12, Rapid Shutdown of PV Systems on Buildings. The switching devices, inverters, and power conversion systems listed within this PVHCS install addendum additionally comply with the 30V in 30 seconds requirements outside the PV array as required in 690.12.

Please see page 6 for list of UL 3741 approved electrical equipment

Approved Electrical Equipment (UL 1741 Listed)



INVERTERS:

- **Canadian Solar Inverters**
 - CSI-xxK-T480GL (followed by 02-U or 03-U) where xx = 75, 80, 90 or 100
 - CSI-30KTL-GS-FLB
 - CSI-40KTL-GS (followed by -FLB or -B)
 - CSI-60KTL-GS-B
 - CSI-xxK-T480GL01-UB, where xx = 25, 30, 36, 40, 50, 60 or 66
- **Chint Inverters**
 - CPS SCA25KTL-DO/US-208
 - CPS SCA25KTL-DO-R/US-480
 - CPS SCAxxKTL-DO/US-480, where xx = 36, 50 or 60
- **Fronius Inverters**
 - Fronius Symo Advanced xx.x-3 208-240/Lite, where xx.x = 10.0 or 12.0
 - Fronius Symo Advanced xx.x-3 480/Lite, where xx.x = 15.0, 20.0, 22.7 or 24.0
- **GoodWe Inverters**
 - GW50K-SMT-US
 - GW60K-SMT-US
 - GW11K4-MS-US30
 - GWxxxx (followed by -MS-US30 or A-MS), where xxxx = 5000, 6000, 7600 or 9600
 - GW8600A-MS
- **SMA Inverters**
 - STP xx-US-41, where xx = 33, 50 or 62
 - STP xx-US-50, where xx = 20, 25 or 30
- **Solectria Inverters**
 - PVI 25TL-208
 - PVI 25TL-480-R
 - PVI 36TL-480-V2
 - PVI xxTL-480, where xx = 50 or 60
- **Solis Inverters**
 - Solis-xxK-US (followed by -SW, -F-SW or -LSW), where xx = 25, 30, 36 or 40
 - Solis-50K-US (followed by -SW, -F-SW, -F-LSW or -LSW)
 - Solis-xxK-US (followed by -F-SW or -F-LSW), where xx = 60 or 66
 - Solis-xxK-5G-US, where xx = 75, 80, 90 or 100
 - S5-GCxxK-US, where xx = 75, 80, 90 or 100
 - S6-GCxxK-US, where xx = 25, 30, 33, 36, 40, 50 or 60
 - Solis-1Pxx.xK-4G-US, where xx.x = 3.06, 5, 6, 7, 7.6, 8.6, 9 or 10
 - S6-EH1Pxx.xK-H-US, where xx.x = 3.8, 5, 7.6, 9.9, 10 or 11.4
 - S6-GCxxK-LV-US where xx = 30 or 60
- **Sungrow Inverters**
 - SGxxCX-US, where xx = 36 or 60

• **Growatt Inverters**

- MINxxxxTL-XH-US, where xxxx = 3000, 3800, 5000, 6000, 7600, 8200, 9000 or 10000

• **NEP (Nothern Electric Power) Inverters**

- NeptunexxK, where xx = 30, 33, 50, 75 or 100
- Neptune30K-LV

• **Portable Solar LLC Inverters**

- 5K-120V/8K-230V-1P
- Sol-Ark-xK-48-ST, where xx = 5 or 8
- Sol-Ark-12K-P
- Limitless 15K-LV

MLPE:

• **APsmart (Rapid Shutdown Device)**

- RSD-S-PLC-A
- RSD-D-15-xxxx, where xxxx = 1000 or 1500
- RSD-D-20-xxxx, where xxxx = 1000 or 1500

• **Beny (Rapid Shutdown Device)**

- BFS-21, where xx = 21 or 22

• **IMO (Rapid Shutdown Device)**

- FRS-xx, where xx = 01 or 02
- FRS-ESWx, where x = 1 or 2

• **SMA (Rapid Shutdown Device)**

- JMS-F

• **NEP (Nothern Electric Power) (Rapid Shutdown Device)**

- PVG-x, where x = 1, 2 or 3

• **Tigo (Rapid Shutdown Device)**

- TAP (Tigo Access Point Gateway), Model 150-10000-50
- TS4-A (followed by -F, -2F, -0, -0-DUO or -S)
- TS4-R (followed by -F, -0, -S, -0-DUO, -S-DUO)
- TS4-X (followed by -F, -0 or -S)

• **Sungrow (Rapid Shutdown Device)**

- SP600S

PVRSE:

• **IMO (Rapid Shutdown Switch)**

- FRS-ESW1
- FRS-ESW2

UL 3741 Listed System With Tesla



String Isolation Device	PV Inverter	Energy Storage Systems
Tesla MCI-2 Max Voltage = 1000V* Max Imp = 13A, Max Isc = 17A	7.6 kW (1538000)**	Powerwall + (1850000)
		Powerwall 3 (1707000)

* Max System Voltage is limited by Tesla Solar Inverter and Powerwall to 600 Vdc

** The inverter can be derated to 3.8kW, 5kW, or 5.7kW if needed

IMPORTANT: Refer to the applicable Tesla Inverter or Powerwall Installation Manual for specific instructions, including MCI-2 mounting, clearances, ratings, compatible connectors, and rapid shutdown initiation methods. MCI-2 installation configurations shown below are specific to the K2 Systems CrossRail System UL 3741 Listing and supersede the MCI-2 configurations shown in the Tesla installation manuals.

NOTE: Utilize listed wire clips to install MCI-2 devices.

Contiguous Arrays

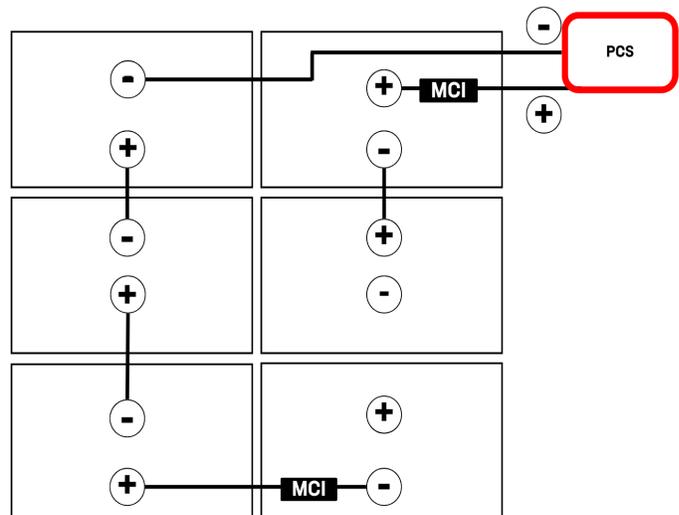
Maximum Voltages After Rapid Shutdown Initiation:

Outside Array Boundary: $\leq 30V$ (30 seconds)

Inside Array Boundary: $\leq 165V$

Where one or more PV strings are connected within a single contiguous array as shown in the figure, Tesla MCI-2s shall be installed with a maximum of 3 modules between MCIs. A Tesla MCI-2 should always be installed on at least one end of a series string, either the "first" or "last" module.

EXCEPTION: Modules installed in locations where the max Voc for three modules at low design temperatures exceeds 165 V shall be limited to two modules between MCIs.



Non-Contiguous Sub-Arrays

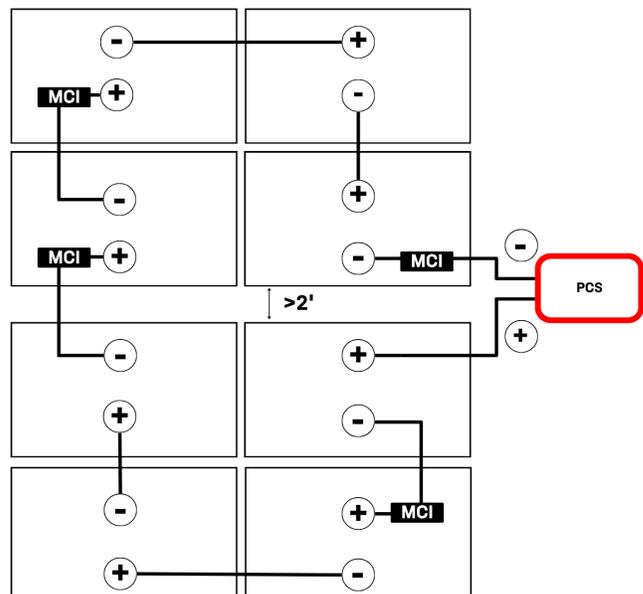
Maximum Voltages After Rapid Shutdown Initiation:

Outside Array Boundary: $\leq 30V$ (30 seconds)

Inside Array Boundary: $\leq 165V$

Where any string is connected across non-contiguous sub-arrays separated by more than 2' (as shown in the figure), an MCI-2 is required at one end of the connection between sub-arrays.

The same installation requirements with a maximum of 3 modules between MCIs applies to each individual sub-array.



Additional Electrical Equipment With Maximum System Voltage 600V



The CrossRail System UL 3741 certification is also applicable when used with MidNite Solar's MNSSR-600S Receiver in combination with either one of the listed inverters and their respective transmitters.

String Isolation Device	PV Inverter	
MNSSR-600S Max Voltage = 600V Max Current =12A	Growatt Models	MIN3000TL-XH-US MIN3800TL-XH-US MIN5000TL-XH-US MIN6000TL-XH-US MIN7600TL-XH-US MIN8200TL-XH-US MIN9000TL-XH-US MIN10000TL-XH-US
	MidNite Solar Models	MN15-12KW-AIO
	Solis Models	Solis-1P3.6K-4G-US Solis-1P5K-4G-US Solis-1P6K-4G-US Solis-1P7K-4G-US Solis-1P7.6K-4G-US Solis-1P8.6K-4G-US Solis-1P9K-4G-US Solis-1P10K-4G-US
	SolArk Models	5K-120V/8K-230V-1P Sol-Ark-5K-48-ST SolArk-8K-48-ST SolArk-12K-P Limitless 15K-LV

*Note: If using this device, arrays are suggested to be $\geq 150V$. Device can not properly function if the array falls below 50V.

IMPORTANT: Refer to the applicable MidNite Solar Receiver and its listed Inverter's Installation Manuals for specific instructions, including MNSRR mounting, clearances, ratings, compatible connectors, compatible transmitters, and rapid shutdown initiation methods. MNSRR-600S installation configurations shown below.

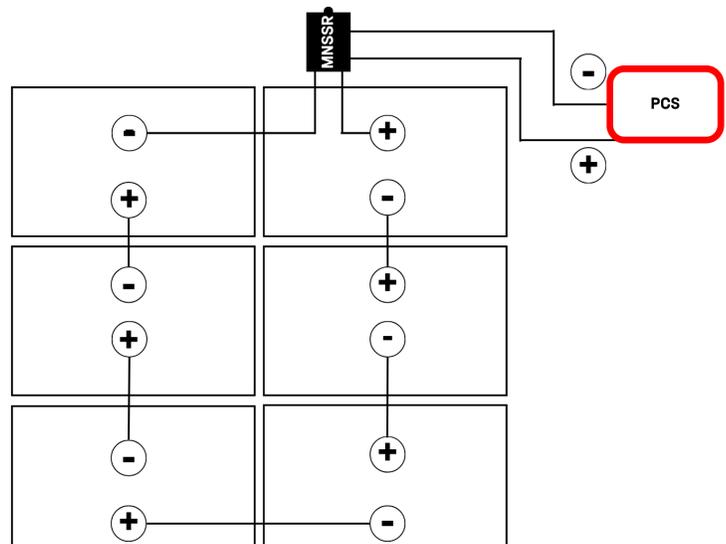
Contiguous Arrays

Maximum Voltages After Rapid Shutdown Initiation:

- Outside Array Boundary: $\leq 30V$ (30 seconds)
- Inside Array Boundary: $\leq 600V$

Where one or more PV strings are connected within a single contiguous array as shown in the figure, each string must install to one MidNite Solar MNSSR.

IMPORTANT: Only one array is supported per device. Consider this option for a contiguous array only.



Introduction: Understanding UL 3741 and NEC 690.12



UL 3741 and NEC Rapid Shutdown Compliance

The CrossRail Photovoltaic Hazard Control System (PVHCS) is a UL 3741 Listed system that provides compliance with the National Electrical Code's (NEC) Rapid Shutdown of PV Systems on Buildings, found in section 690.12. The PVHCS must be installed in accordance with the manufacturer's installation instructions utilizing the materials and methods listed in this addendum.

NEC 690.12 and CrossRail Compliance

NEC requires that specific PV circuits be controlled to reduce shock hazards to firefighter (FF) interactions. The code differentiates the requirements based on the circuit's location in relation to the array boundary. The array boundary is defined as one foot in all directions from the array. In a CrossRail System, the one-foot boundary extends from the edge of the PV modules or racking, whichever is exposed after installation.

NEC defines the array as a mechanically and electrically integrated grouping of modules with support structure, including any attached system components such as inverter(s) or dc-to-dc converter(s) and attached associated wiring.

Outside the Array Boundary

- NEC requires PV system circuit conductors to be reduced to $\leq 30V$ within 30 seconds within rapid shutdown initiation.
- The CrossRail PVHCS complies with this requirement through the use of listed inverters. For proper installation of the inverters, see their respective installation criteria and requirements.

Inside the Array Boundary

- NEC has multiple methods to meet requirements to control conductors within the array boundary. The CrossRail System has been tested to UL 3741 to provide proper protection from shock hazards imposed on FF by system components within the array boundary.
- The CrossRail listing includes the use of multiple isolation devices to control the PV system circuits. Refer to the installation instructions for the string isolation devices as well as this addendum to verify proper installation with the specific isolation device used.

Initiation Devices

- Initiation device(s) shall initiate the rapid shutdown function of the PV system.
- The CrossRail System utilizes initiation devices integrated with the Power Conversion Systems (inverters). Proper installation will include installing the inverters and any associated initiation devices as required.

Installation Methods per UL 3741 and NEC 690.12



The following case studies are provided by K2 Systems to show examples of installation configurations that comply with NEC 690.12, compliance is not limited to these examples.

Case 1 : UL 3741 Listed System, Residential - See page 11

Case 2 : UL 3741 Listed System with Contiguous Sub-Array, Residential - See page 12

Case 3 : UL 3741 Listed System with Multiple Arrays, Residential - See page 13

Case 4 : UL 3741 Listed System, Commercial - See page 14

Case 5 : UL 3741 Listed System with Contiguous Sub-Array, Commercial - See page 15

Case 6 : UL 3741 Listed System with MLPE Sub-Array, Commercial - See page 16

The simplest installation method to comply with NEC is to utilize the CrossRail UL 3741 system with a single array (Case 1 & 4). Installations where sub-arrays can be included within a 1 ft array, or 2 ft total, can be considered a contiguous subarray (Case 2 & 5). With multiple arrays, and more than a 2 ft gap between them, see Case 3 & 6.

For residential systems, all inverter and/or PV circuits (DC) outside of the PV array boundary will require the use of String Isolation Devices (SID) to de-energize circuits leaving the array per NEC after initiation (DC disconnect, AC breaker or AC disconnect). Commercial systems do not require the use of SIDs. Utility Interactive Inverter output circuits (AC) are outside of the array boundary and meet the NEC requirement after initiation (AC breaker or AC disconnect).

Case 1: UL 3741 Listed System, Residential

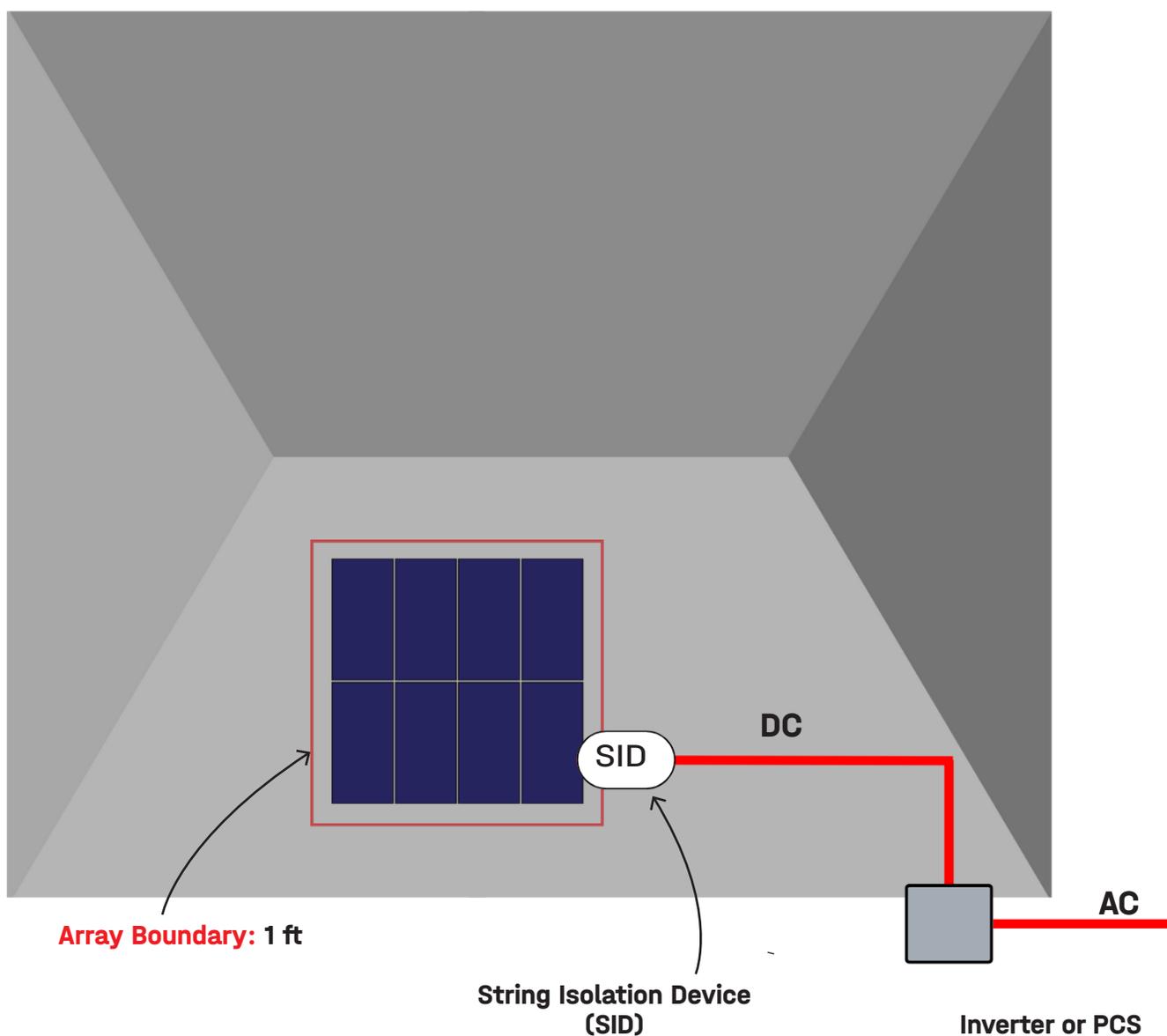
Array(s) comply with NEC 690.12

- Outside Array Boundary: $\leq 30V$ within 30 Seconds
- Inside Array Boundary: $\leq 600V$

Maintaining NEC compliance for single arrays

Single arrays require the use of SID as shown in figure above to control the conductors outside of the array boundary

IMPORTANT: review electrical equipment page(s) for specific approved SID(s) and install methods



Case 2: UL 3741 Listed System with Contiguous Sub-Array, Residential

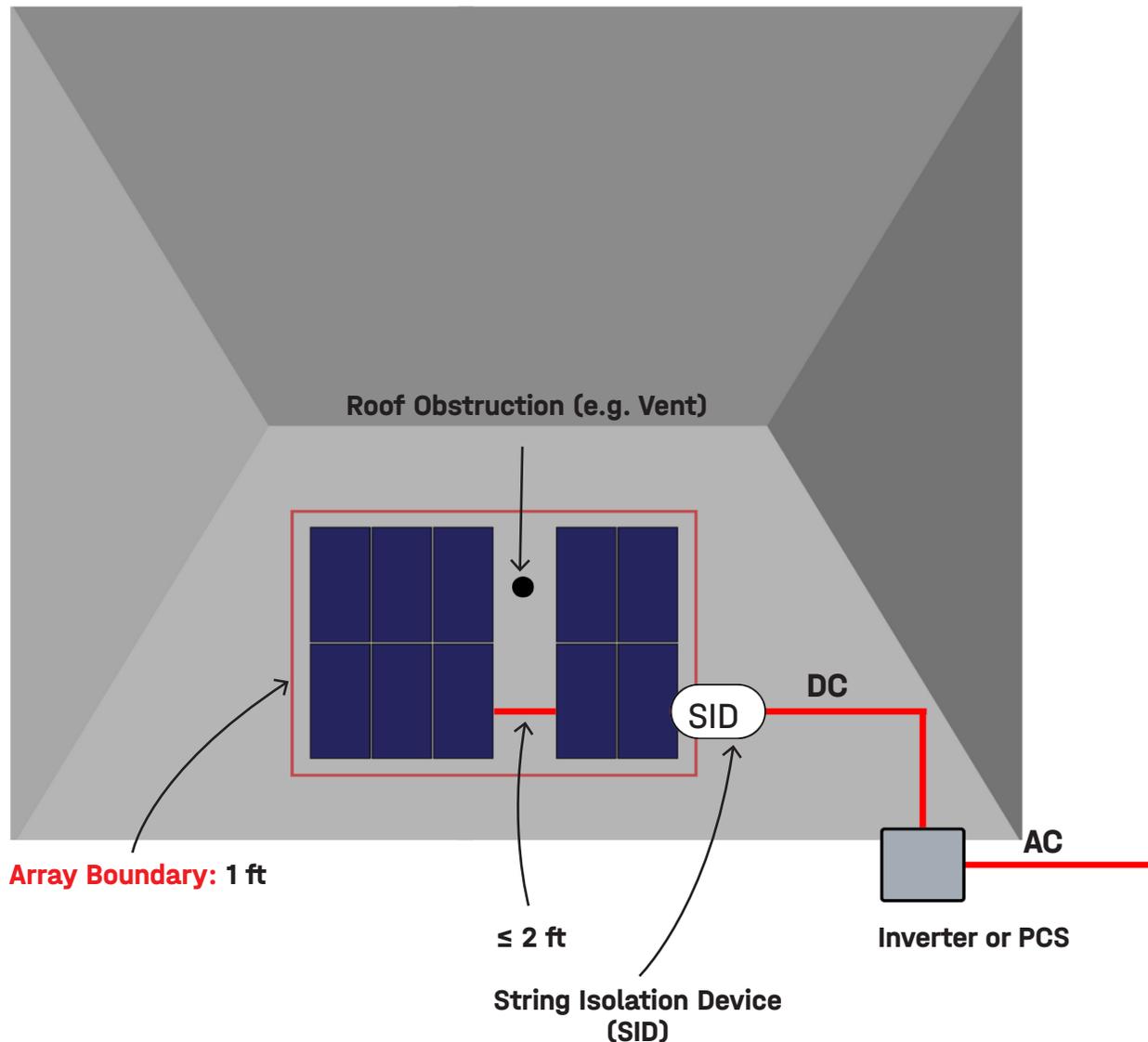
Sub-array(s) within the same array boundary (≤ 2 ft) are considered contiguous and comply with NEC 690.12

- Outside Array Boundary: ≤ 30 V within 30 Seconds
- Inside Array Boundary: ≤ 600 V

Maintaining NEC Compliance with sub-array(s) within array boundary

Multiple sub-arrays with maximum 2ft spacing between sub-arrays result in a contiguous single array boundary and will require the use of a SID as shown above to control conductors outside of the array boundary.

IMPORTANT: Review electrical equipment page(s) for specific approved SID (s) and install methods.



Case 3: UL 3741 Listed System with Multiple Arrays, Residential

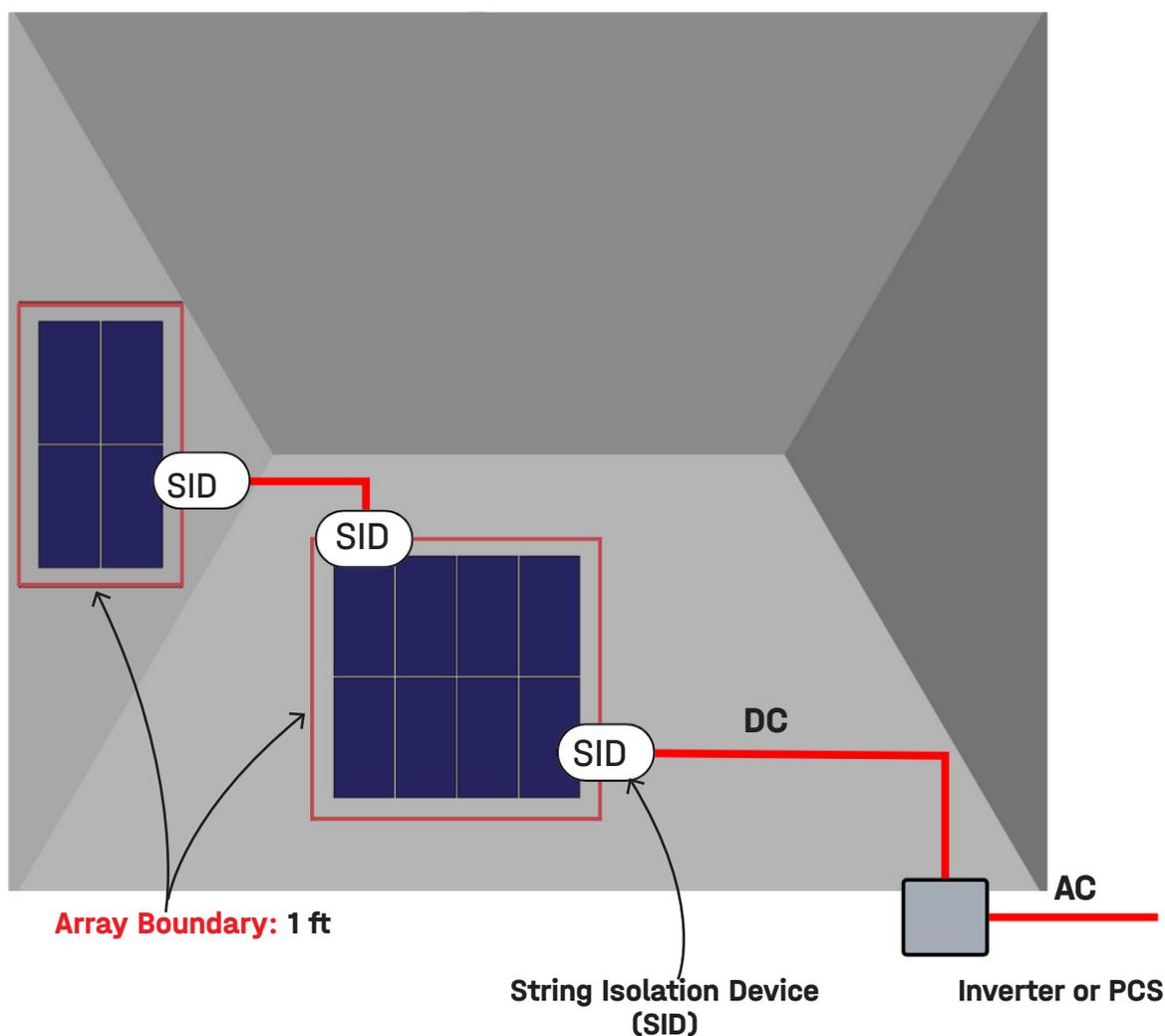
Multiple arrays with multiple strings comply with NEC 690.12

- Outside Array Boundary: $\leq 30V$ within 30 Seconds
- Inside Array Boundary: $\leq 600V$

Maintaining NEC Compliance with multiple arrays

In multiple arrays with multiple strings each string will require a SID. When a string is split across non-contiguous (> 2 ft) sub-arrays, a SID must be installed on both ends of a connection between sub-arrays as shown below to control conductors outside of the array boundary.

IMPORTANT: review electrical equipment page(s) for specific approved SID(s) and install methods



Case 4: UL 3741 Listed System, Commercial

Single arrays comply with NEC 690.12

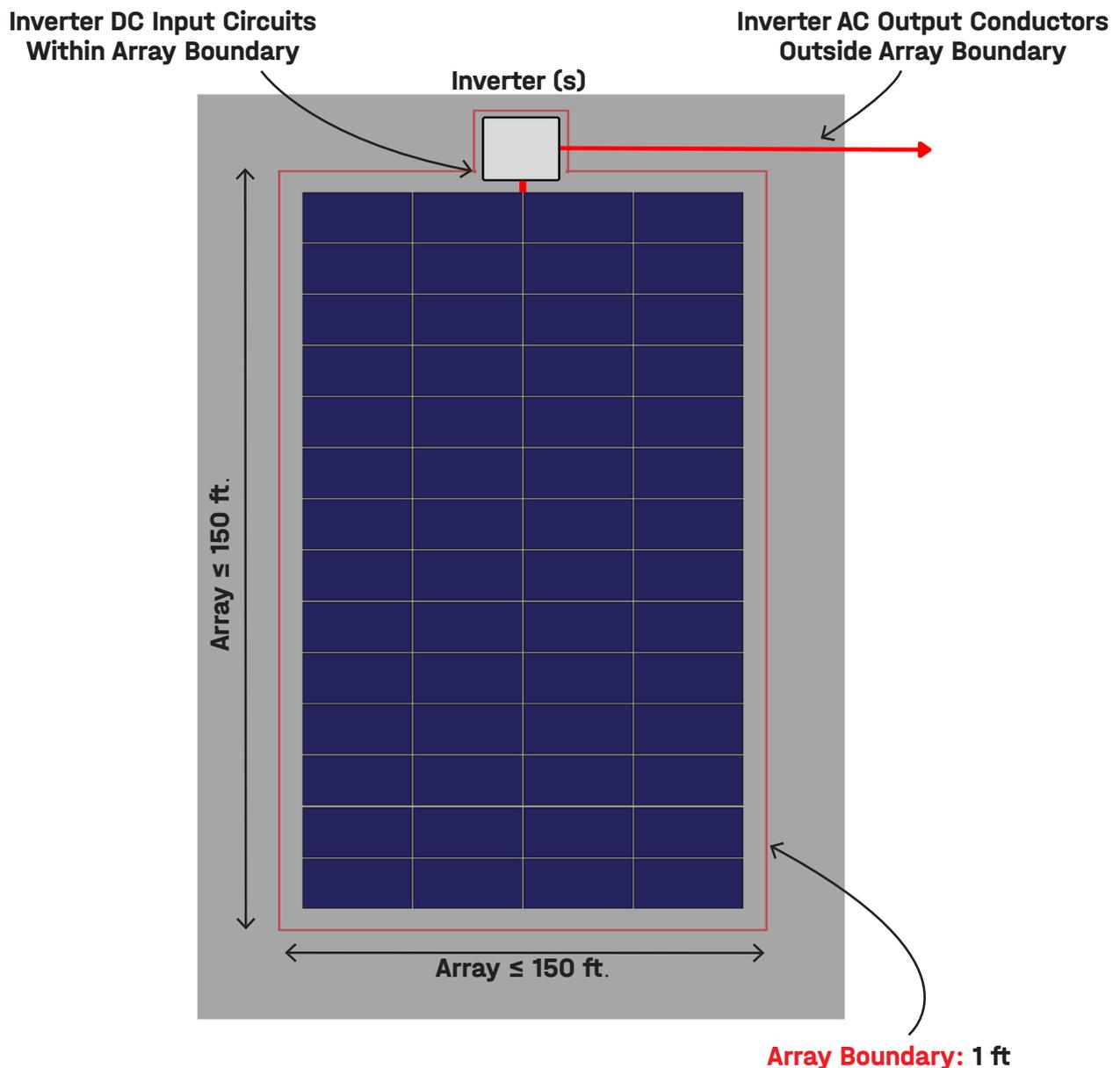
- Outside Array Boundary: $\leq 30V$ within 30 Seconds
- Inside Array Boundary: $\leq 1000V$

Maintaining NEC compliance for single arrays

All inverter input circuits (DC) are contained within the PV array boundary and do not require additional measures to reduce string voltages per 690.12 after initiation (Inverter DC disconnect, AC breaker, or AC disconnect)

Inverter output circuits (AC) are outside the array boundary and meet the 690.12 requirement after initiation (AC breaker or AC disconnect).

IMPORTANT: review electrical equipment page(s) for specific approved SID(s) and install methods



Case 5: UL 3741 Listed System with Contiguous Sub-Array, Commercial

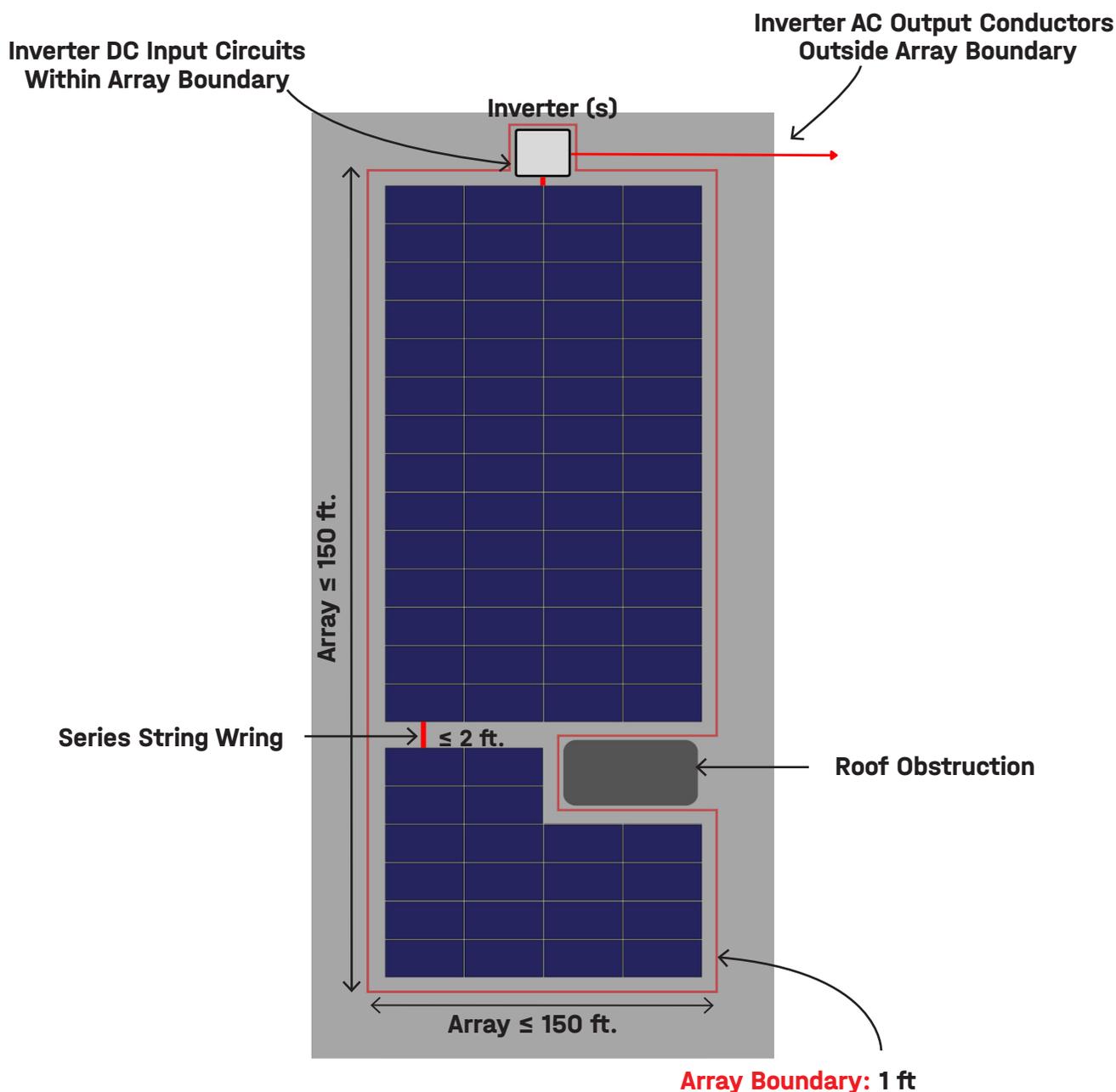
Sub-Arrays(s) that are within the same Array Boundary (≤ 2 ft) are considered contiguous and comply with NEC 690.12

- Outside Array Boundary: ≤ 30 V within 30 Seconds
- Inside Array Boundary: ≤ 1000 V

Maintaining NEC Compliance with sub-array(s) within array boundary

Maximum 2 ft. spacing between all array components, resulting in a single array boundary.

IMPORTANT: review electrical equipment page(s) for specific approved SID(s) and install methods



Case 6: UL 3741 Listed System with MLPE Sub-Array, Commercial

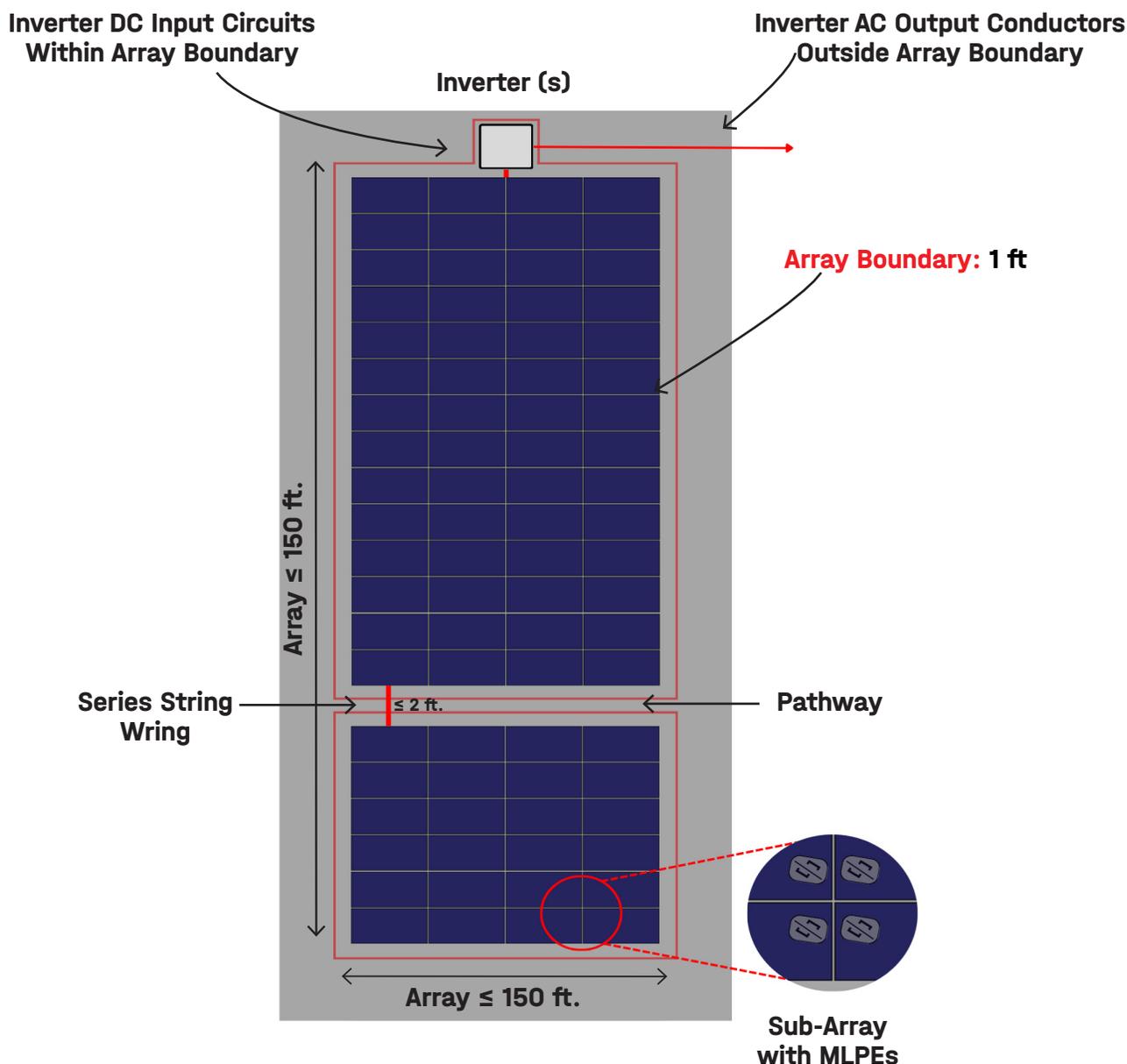
Multiple arrays with multiple strings comply with NEC 690.12

- Outside Array Boundary: $\leq 30V$ within 30 Seconds
- Inside Array Boundary: $\leq 1000V$
- Inside Sub-Array Boundary: $\leq 80V$ within 30 Seconds

Maintaining NEC compliance with multiple arrays

Utilize Module-Level Power Electronics (MLPE's) on lower sub-array. All modules on the same inverter input must be connected to an MLPE. Upper array utilizes UL 3741 listing without MLPEs for compliance.

NOTE: When using MLPE devices, review installation instructions for both the MLPE device and inverter to verify that both devices comply with UL 1741 Rapid Shutdown requirements. If necessary for rapid shutdown functionality, install necessary transmitters outside the array boundary.



UL 3741 Wire Management Guidelines



The CrossRail Wire management components noted in the list of approved PVHCS equipment on page 4 were evaluated and approved for providing wire protection against potential FF interactions. To achieve wire protection as required per UL 3741, all wires shall be routed such that they are not exposed to potential FF interactions. This is achieved using the following methods:

Module Frame Attachment:

- Route PV wires under the cover of modules, and attached to the module frame using approved cable ties and clips
- Do not allow wires to sag between clips, with a maximum of one clip every 24 inches (per NEC 690.31)
- Do not overtighten or pinch wires
- Cut off any remaining cable tie after installation

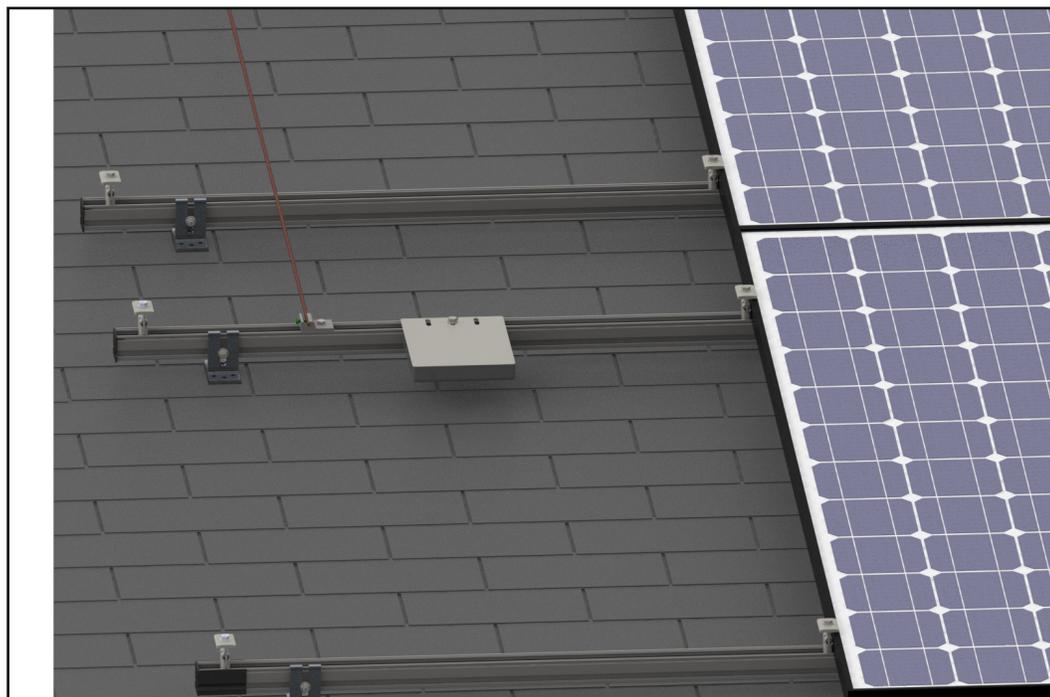
Rail Attachment

- Route PV wires under the cover of modules, and through the mounting rails using approved cable ties and positioning clips
 - PV wires can be run through the open channel of the rails, or attached to the side of the rails
- Do not overtighten or pinch wires
- Cut off any remaining cable tie after installation
- Ensure that PV wires are firmly held in place

Raceways

- Protect wires that must be run through exposed areas, such as the spacing between sub-arrays and FF pathways, by utilizing the listed conduits on page 5
- Ensure that PV wire is not exposed to sharp edges when entering or exiting the raceway.

There shall be no visibly exposed wires after installation of modules. See photos for examples of under module and under chassis wire management:



Wiring is managed under modules; required conduit and cable ties are not shown in the example above.

UL 3741 Wire Management Guidelines



Example of listed edge clip cable tie installation under module, attached to the module frame.

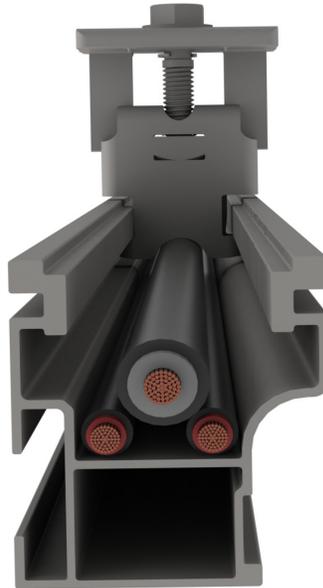


*Example of K2 Dragon Clip installation under module, attached to the module frame.
Note: MiniRail Comp 2.0 mount refers only to these wire management images*

UL 3741 Wire Management Guidelines



Manage bundles of cables using the mounting rails as a listed raceway. When entering and exiting the raceway, installers shall ensure PV wires are never exposure to FF interactions by staying beneath the cover of modules.



Example of wires running through the mounting rails and under the clamps.



Examples of wires held inside the mounting rails with the TC Clip.

UL 3741 Wire Management Guidelines



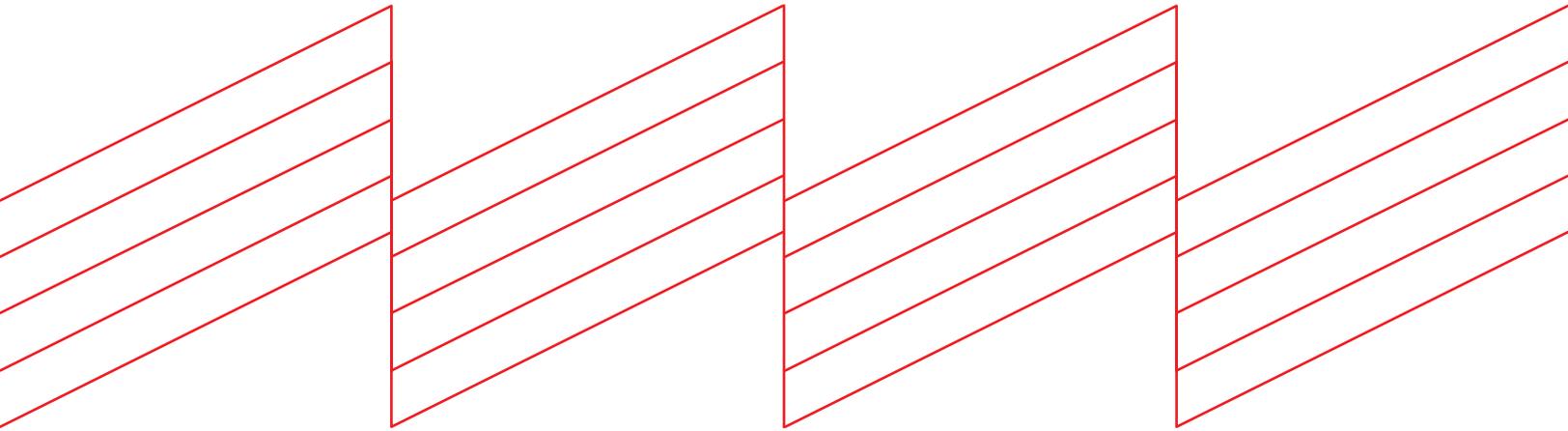
Example of wire installation on the side of the mounting rail using the listed HEYClip SunRunners



Example of wire installation on the side of the mounting rail using listed zip ties.



Connecting Strength



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CrossRail UL 3741 Addendum ENV1 | 0125 • Subject to change
Product illustrations are exemplary and may differ from the original.

Everest Solar Systems S de RL de CV

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