



# UL 3741 PV Hazard Control Installation Addendum

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## Overview

TerraGen's TGR, TGT, TGP systems are a rooftop racking system product line comprised of the same base components, to be assembled in accordance with the appropriate product's Installation Manual. This installation addendum explains how to install the racking system to meet the requirements of the UL 3741 PV Hazard Control Standard. Installers must thoroughly read this manual and understand the installation procedures. Failure to follow the methods and procedures in this guide could cause risk of injury or property damage.

### IT IS THE INSTALLER'S RESPONSIBILITY TO:

- 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.
- Use only TerraGen parts or parts recommended by TerraGen; substituting parts may void any applicable warranty.
- 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.
- Ensure that proper operations and maintenance procedures are followed in accordance with the installation manual.
- Ensure that the system is grounded and bonded to meet the requirements of the applicable local codes and standards.
- Disconnect AC power before servicing or removing modules, AC modules, microinverters and power optimizers.
- Review module manufacturer's documentation for compatibility and compliance with warranty terms and conditions.

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

## Ratings

UL 2703 Certified

UL 3741 Certified



### Conforms to STD ANSI/UL 3741

- Max PVHCS System Voltage: 1000V

### List of Approved Components or Equipment Evaluated at 1000V Max System Voltage:

- All modules that are:
  - Construction equivalent to type 1, 2 or 29 modules.
  - UL 61730 certified
  - Maximum area of 33.2 ft<sup>2</sup>
- TGR, TGT, TGP racking system certified to UL 2703. Refer to applicable installation manual for approved components in each system and installation methods. Example components including but not limited to:
  - Base Rail – 101000, 111000, 117000, 102000
  - Base Rail Splice - 635001, 661001
  - Tilt Assembly - 701000
  - Top Rail – 102000
  - Top Rail Splice – 705001
  - End Clamp – 717001
  - Mid Clamp – 718001
  - Cross Adapter – 719001
  - Bolt, Hex, SS, M8 – 401002
  - Nut, Hex Flanged Serrated - 402001
- TGR, TGT, TGP Accessories which do not impact the bonding path of the system, example components including but not limited to:
  - Angle Bracket – 652001
  - Bolt, Tee - 404001
  - Nut, Hex Flanged Serrated, Lock - 403001
  - Adapter Kit – 903001
  - Swivel Bracket - 910001
  - 3<sup>rd</sup> Party Mechanical Attachments
  - Diagonal Brace, U-Channel – 667000, 670000
  - 3<sup>rd</sup> Party Unistrut, cold rolled steel with pre-galv finish

- Standing Seam clamp Kit – 908001
- 3<sup>rd</sup> Party standing seam attachments, including but not limited to Solar Connections and S-5!.
- Connection Rail – 107000
- Butyl Tape - 512001
- TerraGen Universal Inverter Rack (UIR) consisting of TGR components listed above
- Grounding Lug (UL 467 Listed)
- Wire Management Products
  - Cable Ties (UL 62275 Listed)
  - Wire Clips (UL 1565 Listed)
  - Ray Tray (UL 870 Listed)
- PV Connectors (UL 6703 Listed)
- PV Wire (UL 4703 Listed)
- Listed Conduit (all sizes apply)
  - Electrical Metallic Tubing (EMT) (UL 797 Listed)
  - Flexible Metal Conduit (UL 1 Listed)
  - Intermediate Metal Conduit (IMC) (UL 1242 Listed)
  - Liquid Flexible Metal Conduit (UL 360 Listed)
  - PVC Conduit, Schedule 40 or 80 (UL 651 Listed)
  - Listed Tubing, Fittings, and Grounding Components
  - Wireways and Associated Fittings (UL 870)
- Approved electrical equipment / Inverters that:
  - Are UL 1741 listed
  - Must have PVRSS/PVRSE functions certified by UL 1741
  - Follow the installation locations and guidance of this addendum

## Markings

Product markings are a label pre-applied to the back leg of the tilt assembly for TGR, TGT or on the ends of the top rail for TGP. Each sub array receives it's own label. For ease of locating, it is recommended that the labelled tilt assembly be installed closest to the ground location of each array.

TERRAGEN SOLAR  
TGR, TGT, TGP:  
CONFORMS TO UL 2703  
ddmmyy

See Installation Instructions to  
Achieve the System Fire Class Rating



TERRAGEN SOLAR  
TGR, TGT, TGP:  
CONFORMS TO UL 3741  
ddmmyy

See Installation Instructions to  
Achieve UL 3741 Compliance



## UL 3741 and NEC 690.12

### 2020 NEC 690.12(B)(2) Controlling Conductors within the array boundary

The TGR, TGT, TGP Photovoltaic Hazard Control System (PVHCS) is a UL 3741 Listed system that complies with NEC 690.12(B)(2)(1), when installed by qualified persons per the installation procedures outlined in the TGR Installation Manual and this Addendum. Ensure that all PVRSE, including inverters, are contained within the array boundary per NEC 690.12. Please refer to the following pages of this addendum for various example cases of system designs that comply with 690.12(B)(2).

### 2020 NEC 690.12 Background

2020 NEC690.12 Rapid Shutdown of PV Systems on Buildings requires that all PV arrays installed on or in buildings shall include rapid shutdown functions to reduce shock hazard for Fire Fighters (FF) in accordance with 690.12(A) through (D):

#### A. Controlled Conductors

- (1) PV system DC circuits
- (2) Inverter output circuits originating from inverters located within array boundary

#### B. Controlled Limits

- (1) Outside Array Boundary:  $\leq 30V$  within 30 seconds
- (2) Inside Array Boundary:
  1. Listed PV Hazard Control System (UL 3741)
  2.  $\leq 80V$  within 30 seconds after rapid shutdown initiation
  3. PV array without exposed wiring methods or conductive parts

#### C. Initiation devices

- (1) Initiation device(s) shall initiate the rapid shutdown function of the PV system

#### D. Equipment

- (1) Equipment that performs rapid shutdown functions other than initiation devices, such as listed disconnect switches, circuit breakers, or control switches.

- ❖ *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. This indicates the TGR, TGT or TGP Racking and collocated inverters are part of the array.*
- ❖ *NEC 690.12(B) defines the array boundary as 1ft from array in all directions. This indicates that the array boundary can extend 1ft from the edge of the system racking, inverter or module.*

## Installation Methods Per UL 3741 and NEC 690.12

The array boundary referenced throughout the examples, as described in the NEC, extends 1ft from the contiguous array including the (TGR, TGT, TGP) racking. A contiguous array is an array in which all modules are structurally tied together via typical components while maintaining the specified row spacing (always being continuous through at least 1 point of the array). The array boundary includes the inverter or inverter mounting structure that is located within 1ft of the modules or module (TGR, TGT, TGP) racking.

The following cases are provided as examples covering the different configurations that comply with NEC 690.12(B) utilizing the TGR, TGT or TGP system with UL 3741. Compliance is not limited to these examples.

For a contiguous array with one or more collocated inverters, all inverter DC input circuits must be within the 1ft array boundary (Case 1). If a sub-array's 1ft boundary is shared with the main array's, this creates a single array boundary and can comply by following Case 2. Sub-arrays which cannot be included within the 1ft array boundary can comply by using a Case 3 & 4 or a combination of them.

**Case 1: UL 3741 Listed System**

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

**Case 3: UL 3741 Listed System with Non-Contiguous Sub-Array**

**Case 4: UL 3741 Listed System with MLPE Sub-Array**

**Case 1:**

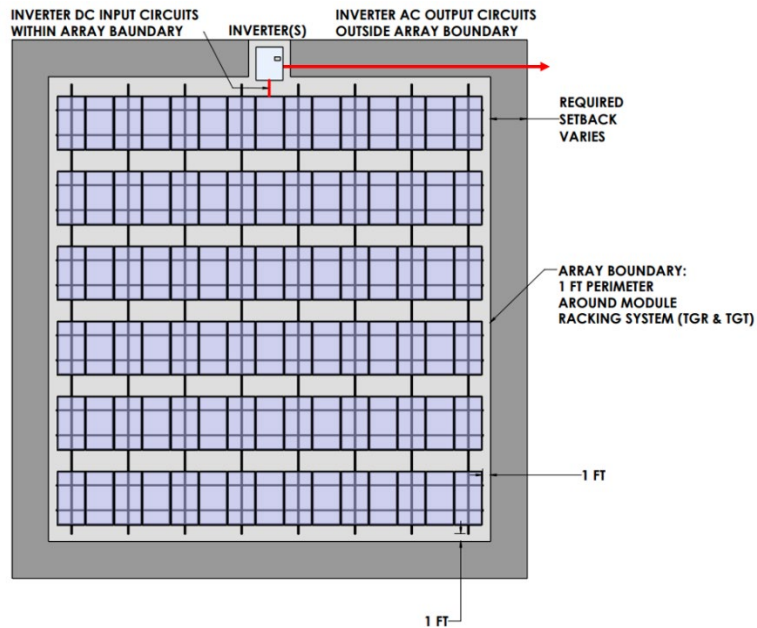
Array(s) comply with 690.12(B) by utilizing a UL 3741 PV Hazard Control System

**PV Circuit Voltages:**

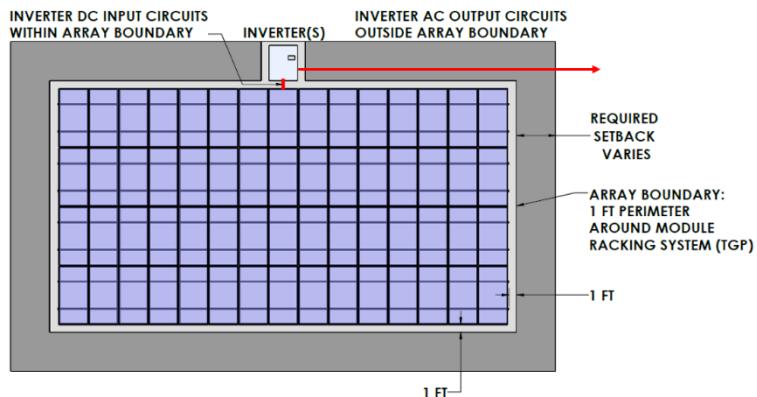
**Outside Array Boundary:** ≤ 30V within 30 seconds

**Inside Array Boundary:** ≤ 1000V

***TGR (Commercial Flat Roof) & TGT (Commercial Tilted Pitched Roof)***



***TGP (Commercial Flush Mount)***



**Notes:**

- 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(B)(2)(1) after initiation (Inverter DC disconnect, AC breaker or AC disconnect).
- Inverter output circuits (AC) are outside of the array boundary and meet the 690.12(B)(1) requirement after initiation (AC breaker or AC disconnect).



**Case 2:**

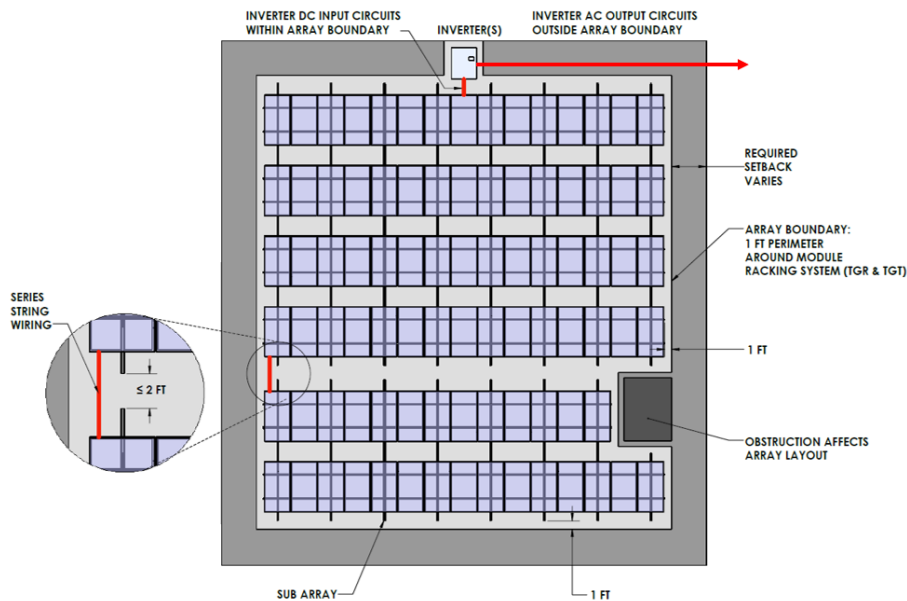
Sub-array(s) share the same boundary and array(s) comply with 690.12(B) by utilizing a UL 3741 PV Hazard Control System

**PV Circuit Voltages:**

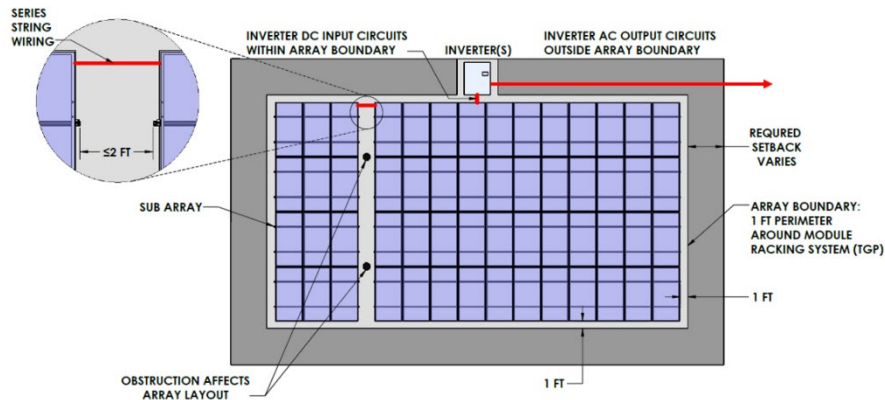
Outside Array Boundary:  $\leq 30V$  within 30 seconds

Inside Array Boundary:  $\leq 1000V$

**TGR (Commercial Flat Roof) & TGT (Commercial Tilted Pitched Roof)**



**TGP (Commercial Flush Mount)**



**Notes:**

- To maintain NEC compliance with sub-array(s), maximum of 2ft spacing between array components results in a single array boundary and complies with 690.12(B) by utilizing a UL 3741 PV Hazard Control System.

**Case 3:**

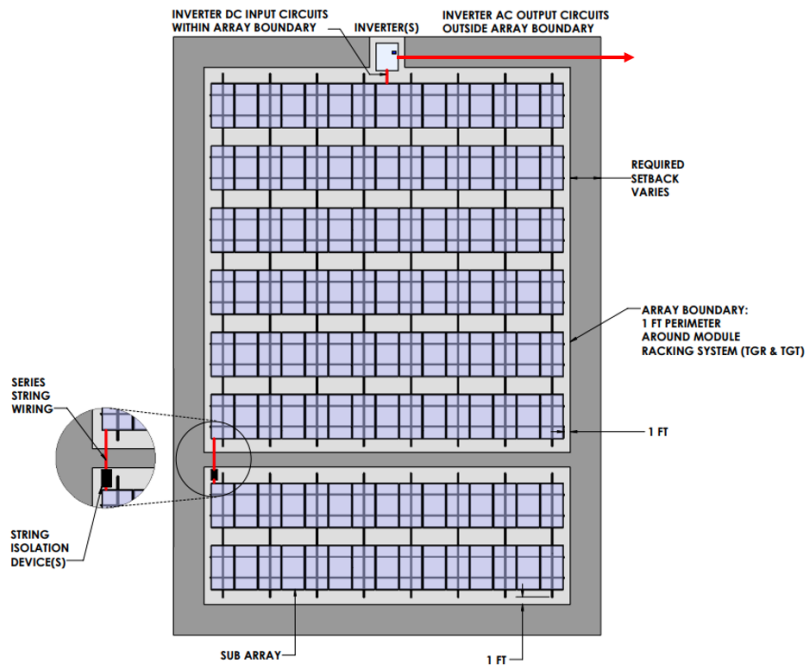
Sub-array(s) with conductors outside of array boundary are controlled via String Isolation Device(s)

**PV Circuit Voltages:**

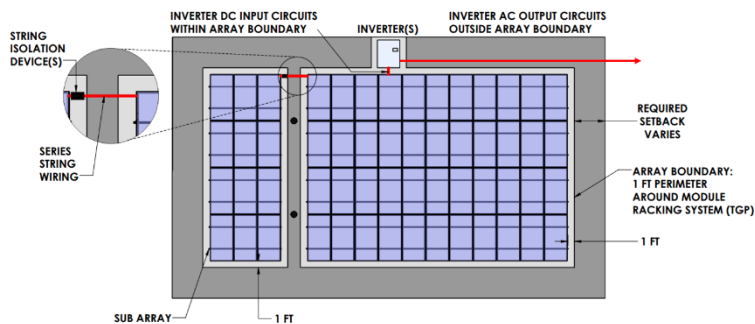
Outside Array Boundary:  $\leq 30V$  within 30 seconds

Inside Array Boundary:  $\leq 1000V$

**TGR (Commercial Flat Roof) & TGT (Commercial Tilted Pitched Roof)**



**TGP (Commercial Flush Mount)**



**Notes:**

- To maintain NEC compliance with sub-array(s) outside of array boundary, complete string must be connected to a single isolation device. If used for a partial string, isolation devices required on both sides of the pathway since voltage will be present on both sides.

**Case 4:**

Sub-array(s) with conductors outside of array boundary comply using MLPEs to control circuits for 690.12(B)(1) and (B)(2) compliance

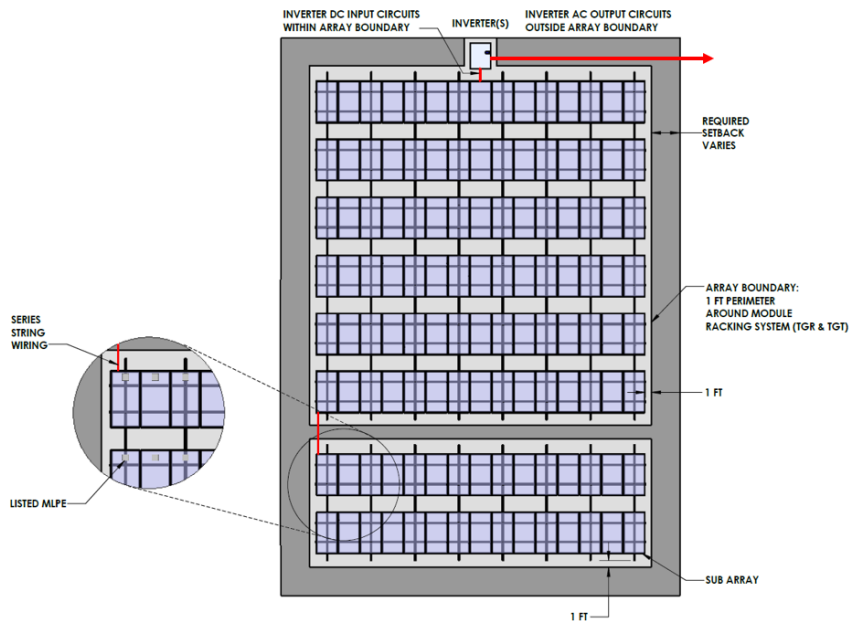
**PV Circuit Voltages:**

**Outside Array Boundary:** ≤ 30V within 30 seconds

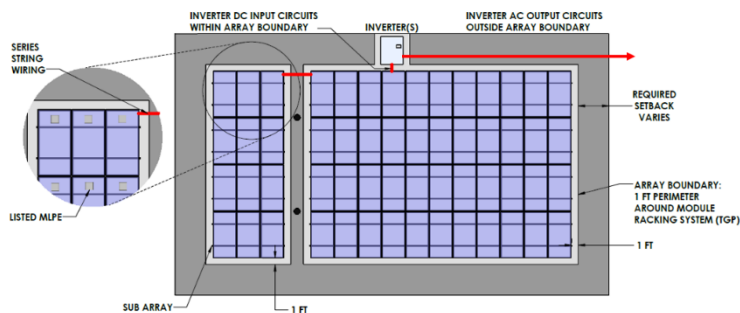
**Inside Array Boundary:** ≤ 1000V

**Sub-Array Boundary:** ≤ 80V within 30 seconds

***TGR (Commercial Flat Roof) & TGT (Commercial Tilted Pitched Roof)***



***TGP (Commercial Flush Mount)***



**Notes:**

- To maintain NEC compliance with sub-array(s) outside of array boundary, utilize Module Level Power Electronics on lower sub-array.
- All modules on the same inverter input must be connected to an MLPE. Upper array utilizes UL3741 listing without MLPEs for compliance.
- **MLPE device and Inverter must comply with UL 1741 Rapid Shutdown requirements.**

## UL 3741 Wire Management Guidelines

The wire management components listed in this document are approved for protection as required per UL 3741 provided they are installed in such a way that:

- All wires will be routed under modules or through approved components so as not to leave any exposed to possible FF interactions.
- Route wires under modules along module rows, not allowing wires to sag between clips.
  - Examples shown below utilize zip ties or rail clips on the top rail.
- Routing wires through between rows where not covered by the module requires an approved cover.
  - Examples shown below utilize approved conduit between rows.
- Manage larger bundles of wires in exposed areas such as between rows and in pathways by utilizing listed raceways. When entering and exiting the raceway, installers shall ensure wires are routed away from exposure to Fire Fighter interactions.

