

Subject 2703

August 16, 2018

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels, UL 2703, are being proposed for preliminary review and comment only:

1. For Preliminary Review Only: Bonding and Grounding Revisions.

COMMENTS DUE: August 30, 2018

This proposal is for review and comment only (no ballot at this time). Please note that comments on a preliminary review document will not receive a response from the proposal author through CSDS. Instead, the proposal author will be asked to review the comments and adjust the proposals and/or supporting rationale as the author determines to be appropriate. The preliminary review process is an informal mechanism that provides authors with the opportunity to refine their proposals before they advance to the next stage in UL's standards development process.

In some cases, the author of the proposals may choose to discontinue them. In this case, the author need not do anything after preliminary review has ended. Normally, the next step in the process is the more formal STP ballot and stakeholder review process. Only comments posted during the STP ballot and stakeholder review process will be provided with a response in CSDS.

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~.

1. For Preliminary Review Only: Bonding and Grounding Revisions.

RATIONALE

Proposal submitted by: Jeff Spies, Quick Mount PV, on behalf of the UL 2703 Bonding and Grounding Task Group

Reference	Technical Rationale for proposed revisions
1.1	Changed "components" to "devices" for consistency throughout standard whenever referring to devices that are part of the system fault current ground path.
1.2	Increased the maximum system voltage from 1000 V to 1500 V due to NEC 690.7, which now allows PV system voltages up to 1500 V.
2.8	Introduced two new terms required for the new multiple use bonding test. This test is being introduced to provide validation for devices that are suitable for multiple installations.
2.23	Refine the definition of MACHINE SCREW to clarify the distinction between screws that use spaced threads vs. those that use machine screw thread forms. This is a core element to resolving the undefined term in the current standard of "sheet metal screw".
2.26	MODULE LEVEL POWER ELECTRONIC (MLPE) DEVICE is defined in the standard as these devices may be a part of the system grounding circuit.
2.39	SHEET METAL SCREW is defined as it is used in the standard and there is no accepted industry definition of sheet metal screw. We have clarified that SHEET METAL SCREW refers to screws using a "spaced thread form"

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Table Continued

Reference	Technical Rationale for proposed revisions
8.7	Added to address AHJ concerns over the effect of routine maintenance will not involve breaking or disturbing the bonding to ground path.
9.1	1) Eliminated the requirement for the system to be “non-separately derived”. There is no difference between a SDS and a NSDS with respect to the equipment grounding system. SDS refer to the grounding of circuit conductors, it does not refer to equipment grounding system, which is continuous on a SDS. 2) Added additional examples of metal accessories 3) Added “UL” before UL 1565 and UL 62275
9.2	Clarified the requirement for routine maintenance to not break or disturb the bonding path. The terminology was not clear that this pertained to the PV module and the racking as a system.
9.3	Clarified that machine screws (including self drilling tapping types) are an permissible positive mechanical means for securing bonding devices to a racking system.
9.6	1) Clarify that bonding strap meets the NEC requirements for protected and unprotected grounding conductors. 2) Clarify that bonding straps comply with NEC sizing requirements 3) Differentiate between pull test requirements for Flat bonding straps with flat end terminations/crimps and bonding straps with non flat terminations/crimps 4) Replace table 9.1 for size of equipment grounding and grounding electrode conductors from the NEC.
9.11 and 9.12	Introduce new multiple use bonding device test for grounding devices that can be used more than one time
9.13	Clarify that MLPE devices that are connected to the PV Module Frame do not need to be evaluated with the racking system if they are connected to the PV Module Frame using a listed bonding device.
12.1	1) Eliminate the TC 200 test as there have never been failures of the TC-200 test if you pass humidity freeze test. This test was originally adopted from UL 1703 and while valuable to testing a module made with laminated materials that have widely variable coefficients of expansion contraction, this expansion contraction vulnerability does not exist with racking systems. 2) Clarify the number of samples for bonding conductor test
Table 16.2	Update to reflect the deletion of Section 17, Temperature Cycling Test.
17	Eliminate the TC 200 test as there have never been failures of the TC-200 test if you pass humidity freeze test. This test was originally adopted from UL 1703 and while valuable to testing a module made with laminated materials that have widely variable coefficients of expansion contraction, this expansion contraction vulnerability does not exist with racking systems.
18.7	1) revise to recognize that the vertical orientation may not be worst case for maintaining of spacings and ground paths 2) delete references to TC 200 test
21.9	Update to reflect the deletion of Section 17, Temperature Cycling Test.

Table Continued

Reference	Technical Rationale for proposed revisions
22.1	1) Changed “components” to “devices” for consistency throughout standard whenever referring to devices that are part of the system fault current ground path. We have determined that the term “device” is different than a “Listed” device. If the term “device” is used without the qualifier “listed” it is being used in a generic language manner to refer to a part of the system. 2) Allow for alternate short circuit testing method using the UL 467 Short Time Current Test. 3) Clarify the power supply needed for the Limited Short Circuit Test
22.2	Clarify the voltage of the test circuit for the overcurrent test and require Voc verification before and after test.
22.4	Introduce multiple use bonding device test.
23.1	Clarify this test is for flat/flat end termination bonding straps
26.2	Provide reciprocity for the evaluation of bonding grounding system between UL 1703 and UL 2703
26.7	Address how installation instructions must reference the removal and reinstallation procedure.
Appendix A	Added UL 467, UL 1565, and UL 62275
Appendix B	Update to reflect the deletion of Section 17, Temperature Cycling Test.

PROPOSAL

1.1 These requirements cover rack mounting systems, mounting grounding/bonding ~~components~~ devices, and clamping/retention devices for specific (manufacturer/model designation) flat-plate photovoltaic modules and panels that comply with the Standard for Flat-Plate Photovoltaic Modules and Panels, UL 1703, intended for installation on or integral with buildings, or to be freestanding (i.e., not attached to buildings), in accordance with the National Electrical Code, ANSI/NFPA 70 and Model Building Codes. Systems, components and/or devices evaluated under this standard may be used to ground and/or mount a PV module complying with UL 1703 when the specific module or frame has been evaluated for bonding/grounding or the module has been evaluated for mounting with the evaluated system, component or device.

1.2 These requirements cover rack mounting systems and clamping devices intended for use with photovoltaic module systems with a maximum system voltage of ~~1000~~ 1500 V.

2.8 BONDING DEVICE – A device for bonding and may include a function to pierce non-conductive coatings such as but not limited to; anodization, paint, vitreous enamel, and may be a separate piercing device or integral to the component to perform the bonding function.

a) SINGLE USE BONDING DEVICES – Bonding device intended for use one time only.

b) MULTIPLE USE BONDING DEVICE – Bonding device intended for multiple use according to the device's installation instructions.

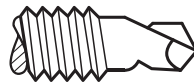
2.23 MACHINE SCREW – ~~A threaded fastener which is utilized with a threaded nut or internal threads in a material, to provide a clamp load on the mechanical joint being fastened. See ANSI/ASME B18.6.3 for illustrations of the various types of machine screws. A machine screw is a fastener defined by ASME B18.6.3 meeting UN or UNR requirements such as UNC, UNF, and UNS thread types defined by ASME B1.1 as well as the M series metric screws defined by ASME B1.13M. There are thread cutting and self-drilling tapping machine screws. Examples of thread cutting screws include Types, D, F, G, T, 1, 23 as defined by ASME B18.6.3. These screws are permitted by the NEC 2014, Section 250.8, to be used~~

for bonding and grounding applications. Examples of self-drilling tapping machine screws include CSD screws as defined by SAE J78. These screws have UN style threads with a drill point for creating the pilot hole for the screw.

Thread-Cutting Machine Screw



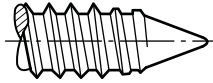
Self-Drilling Tapping Machine Screw



2.26.1 MODULE LEVEL POWER ELECTRONIC (MLPE) DEVICE – Device connected to PV module frame or racking system that performs module level electrical control and/or monitoring.

2.39.1 SHEET METAL SCREW – A thread forming or thread cutting screw with spaced threads which allow for material displacement during threading. The threads per inch for sheet metal screws are less than those for machine screws (UNC, UNF, or M as defined by ASME B1.1 and ASME B1.13M). Examples of sheet metal screws include Type A, AB, ABR, B, BP, BF, BT and 25 as defined by ASME B18.6.3. Sheet metal screws are not permitted for bonding and grounding applications in accordance with the NEC 2014, Section 250.8.

Sheet Metal Screw with Spaced Threads



8.7 Routine maintenance of a mounting system, module or panel shall not involve breaking or disturbing the bonding to ground path of the system. A bolt, screw, or other part used for bonding purposes, which is an integral part within the construction of a mounting system, module or panel, or is a dedicated/identified grounding or bonding point, shall not also be intended for securing the complete device to the supporting surface or rack frame.

9 Bonding

9.1 Mounting system and clamping/retention device(s) shall have a means for bonding all accessible potentially conductive parts to ground. The grounding means shall comply with the applicable requirements in Grounding and Grounding Devices, Section 8. The grounding means shall be bonded to each conductive part of the rack mounting systems and clamping devices. The grounding means shall be described in detail in the installation manual. See Installation, Assembly and Maintenance/Inspection Instructions, Section 26.

Exception: ~~For non-separately derived systems, a~~ Accessible conductive components that are not a part of the fault current ground path such as flashings, roof attachments, Lfeet, tile hooks, skirts, ballast trays and wind deflectors, and metal roofing panels are not required to be electrically bonded when the following are all true:

- a) The fault current ground path components of the system are clearly marked.*
- b) The installation instructions clearly identify the system's fault current ground path components and their methods of assembly.*
- c) The accessible conductive component is not likely to be energized other than through direct or indirect contact with other accessible conductive components that are likely to be energized under normal operations or single fault conditions.*

In addition, a suitable wire positioning device that complies with the Standard for Positioning Devices, UL 1565, or the Standard for Cable Management Systems - Cable Ties for Electrical Installations, UL 62275, is not required to be electrically bonded.

9.2 Routine maintenance of a PV module and mounting system ~~or panel~~ shall not involve breaking or disturbing the bonding path of the system. A bolt, screw, or other part used for bonding purposes, which is an integral part within the construction of a PV module mounting system ~~module or panel~~, or is a dedicated/identified grounding or bonding point, shall not also be intended for securing the complete device to the supporting surface or rack frame.

9.3 The securement of bonding devices or achieving bonding shall be by positive mechanical means, such as clamping, riveting, bolted or screwed connections (see 6.5 and 6.6), or welding, soldering (see 9.5) or brazing. The bonding connection/device shall penetrate nonconductive coatings, such as but not limited to anodization, paint or vitreous enamel. Machine screws of all types are considered to be a positive mechanical means. Sheet metal screws are not considered a positive mechanical means. Sheet metal threaded fasteners are not positive mechanical means.

9.6 A separate bonding conductor or bonding strap shall:

- a) Be of copper and its alloys, aluminum and its alloys, 300 series stainless steel, or other material acceptable for use as an electrical conductor;
- b) Be protected from Where there is risk of mechanical damage, a minimum 6 AWG strap shall be used or the strap shall be protected from mechanical damage by using methods such as a protective raceway or routing straps along structural elements;
- c) Be secured via a positive mechanical means (see 9.3). If secured by a removable fastener, the fastener shall be used only to secure the bonding conductor or strap if it is likely that the bonding conductor or strap would not be reinstalled after removal and replacement of the fastener;
- d) If terminations are included, be factory crimped terminations, not field crimped;
- e) Comply with the sizing requirement in Table 9.1. A separate bonding conductor or bonding strap shall have a minimum size or be rated to carry the required current in accordance with the following:
 - 1) For a dc input from a photovoltaic source or output circuit, 1.25 times the rated short-circuit input current for that input.
 - 2) For any ac input or output circuit or dc (non-PV) input or output circuit, Column 2 of Table 9.1 based on the size of the overcurrent device protecting that circuit.

Exception: A smaller conductor or strap is usable when it complies with Bonding Conductor Test, Section 22.

- f) Bonding straps with non-flat terminations/crimps are Be subject to the Bonding Path Resistance Test, Section 13; ~~Temperature Cycling Test, Section 17;~~ Humidity Test, Section 18; Bonding Conductor Test, 135%, 200% and Limited Short Circuit, Section 22 and evaluated in accordance with the Standard for Grounding and Bonding Equipment, UL 467; and or
- g) Flat bonding straps with flat end terminations/crimps, are subject to the Bonding Path Resistance Test, Section 13; Temperature Cycling Test, Section 17; Humidity Test, Section 18; Bonding Conductor Test, 135%, 200% and Limited Short Circuit, Section 22, and a the Bonding Strap Pull Test, Section 23; and
- g) h) If a flat bonding strap with flat end terminations/crimps, be subject to the Bonding Path Resistance Test, Section 13; ~~Temperature Cycling Test, Section 17;~~ Humidity Test, Section 18; Bonding Conductor Test, 135%, 200% and Limited Short Circuit, Section 22, and a the Bonding Strap Pull Test, Section 23.