

## STANDARD INFORMATION

**Amendment 1:** See addition of August 3, 2020 revision date, and updated effective date in blue below.

**Standard:** UL 1741

**Standard ID:** Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources [UL 1741:2021 Ed.3]

**Previous Standard ID:**

Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources [UL 1741:2010 Ed.2+R:10Jun2021]

Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources [UL 1741:2010 Ed.2+R:25May2021]

Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources [UL 1741:2010 Ed.2+R:16Sep2020]

Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources [UL 1741:2010 Ed.2+R:03Aug2020]

## EFFECTIVE DATE OF NEW/REVISED REQUIREMENTS

**Effective Date:** ~~September 28, 2023~~ September 28, 2024

## IMPACT, OVERVIEW, AND ACTION REQUIRED

**Impact Statement:** Per our accreditation, Intertek is required to review reports against the standard revisions to confirm compliance. Once compliance is confirmed, the standard reference in the report is updated to show continued compliance to the technical requirements of the standard. Reports not updated to this version by the effective date above will be withdrawn.

All reports must be certified to the September 28, 2021 (3<sup>rd</sup> Ed.) revision prior to the effective date.

### Overview of Changes:

#### August 3, 2020:

- Requirements for AC Modules and Including Requirements for PV Modules with Integrated Electronics
- Revision to Disconnect Device Actuator Options
- Revisions to Cover Interconnection Requirements from IEEE 1547-2018 and IEEE 1547.1- 2020;

#### September 16, 2020:

- Admin revision, no technical changes

#### May 25, 2021:

- Usage of Maximum Input Short-Circuit Current for Abnormal Tests
- Power Connector Mate-Ability
- Additional Requirement Clarifying Panelboard Functionality



**June 10, 2021:**

- Trunk Cable Stranding
- Field Repair of AC PV Modules
- Trunk Cables for Multiple Inverters

**September 28, 2021**

- Revisions to Supplement SB – Grid Support Utility-Interactive Inverters and Converters

Specific details of new/revised requirements are found in table below.

***Current Listings Not Active? – Please immediately identify any current Listing Reports or products that are no longer active and should be removed from our records. We will do this at no charge as long as Intertek is notified in writing prior to the review of your reports.***



## STANDARD INFORMATION

CLAUSE	VERDICT	COMMENT
		<i>Additions to existing requirements are <u>underlined</u> and deletions are shown <del>lined out</del> below.</i>
<b>The following changes reflect the August 3, 2020 revision</b>		
15	Info	<b>Disconnect Devices</b>
15.1	Info	<b>General</b>
		System Disconnecting Means: A device serving the function of the NEC-required system disconnecting means shall:
15.1.3		a) Consist of a manually operated switch or a circuit breaker, b) Employ an <del>operating handle</del> <u>actuating mechanism</u> that is accessible from outside of the enclosure or located behind a hinged cover not requiring a tool (other than a key) for opening, and c) Be marked in accordance with 66.21 and 66.27.  <u>Disconnect actuating mechanisms shall clearly indicate the operational status of the disconnect with the following text "ON (CLOSED)" and "OFF (OPEN)" or symbols in accordance with 66.21.</u>
		Equipment Disconnecting Means: A device serving the function of the NEC-required equipment disconnecting means shall:
15.1.4		a) Consist of a manually operated switch or a circuit breaker, b) Employ an <del>operating handle</del> <u>actuating mechanism</u> that is capable of being operated without exposing the operator to inadvertent contact with live parts, and c) Be marked in accordance with 66.21 and 66.27 to indicate its function.  <u>Disconnect actuating mechanisms shall clearly indicate the operational status of the disconnect with the following text "ON (CLOSED)" and "OFF (OPEN)" or symbols in accordance with 66.21.</u>
<b>Interactive Equipment</b>		
43		Section 43 has been completely rewritten.  See standard for details.



CLAUSE	VERDICT	COMMENT
49	Info	<b>Utility Compatibility</b>
		<i><b>New clause added;</b></i>
49.2		Grid support interactive inverters and ISE shall comply with: a) Supplement SA for Grid Support Utility-Interactive Equipment, and/or b) Supplement SB for Grid Support Utility-Interactive Inverters and Converters Based upon IEEE 1547-2018 and IEEE 1547.1-2020.
		<i><b>New clause added;</b></i>
49.3		Special purpose interactive inverters and ISE shall comply with the corresponding requirements for the manufacturer's product ratings and stated compliance with specific interconnection requirement(s).
	Info	<b>MARKING</b>
66	Info	<b>Details</b>
66.21		Both the on and off positions of the disconnect control devices specified in Switches and Controls, Section 12, or in <u>Disconnect Devices</u> , Section 13, shall be identified. The symbols illustrated in Figure 66.5 are usable for this purpose. The identification shall not be by illumination only. See 66.22.
		<i><b>New section added;</b></i>
71		<b>Production Tests for Interactive Equipment</b>
71.1		Products rated for compliance with IEEE 1547-2003 and IEEE 1547.1-2005 shall comply with the applicable requirements in IEEE 1547.1- 2005, Section 6, Production tests.
	Info	<b>CONSTRUCTION</b>
		<i><b>New section added;</b></i>
		<b>General</b>
85		An ac module that is capable of utility interactive operation shall comply with the requirements for utility-interactive inverters in Sections 6 – 71.  See standard for details.
	Info	<b>PERFORMANCE</b>
		<i><b>New section added;</b></i>
		<b>General</b>
86		Where electronics are mounted to the PV module with adhesive, the securement to the module shall be in accordance with PV Module Mounted Equipment Securement Test, Section 87.  See standard for details.



CLAUSE	VERDICT	COMMENT
		<b><i>New section added;</i></b>
		<b>ACPV Module Mounted Equipment Securement Test</b>
87		Equipment secured to PV module with adhesive shall comply with 83.3 – 83.7 Sequence C in Figure 1 of the Standard for Photovoltaic (PV) Module Safety Qualification – Part 2: Requirements For Testing, UL 61730-2. During the MST 16 testing of Sequence C, the electronics may alternatively be tested with the Dielectric Voltage-Withstand Test, Section 47, in place of the Sequence C Insulation Test.  See standard for details.
		<b><i>New section added;</i></b>
		<b>Module to Electronics Bonding</b>
88		Equipment bonding between the PV modules and electronics having accessible conductive surfaces shall comply with this Section.  See standard for details.
	Info	<b>RATING</b>
		<b><i>New section added;</i></b>
		<b>General</b>
89		AC module inverters and other module mounted electronics that are provided integral to the PV modules are not required to be provided with the dc input ratings specified in items (a) – (e) in Table 65.1.  See standard for details.
		<b><i>New section added;</i></b>
		<b>Details</b>
90		AC modules and other module mounted electronics shall be marked with the maximum number of series and or parallel connected units to which it is intended to be connected.  See standard for details.
91	Info	<b>Important Safety Instructions</b>
		<b><i>New clause added;</i></b>
91.1		The important safety instructions shall include a statement(s) indicating the applicable information in Sections 89 and 90.



CLAUSE	VERDICT	COMMENT
Supplement SA		<b>GRID SUPPORT UTILITY INTERACTIVE EQUIPMENT</b>
SA1	Info	<b>Scope</b>
SA1.1		<p>These requirements cover grid support utility interactive inverters, converters <u>and ISE</u>. This Supplement to UL 1741 is intended to validate compliance with grid interactive functions which are not covered in IEEE 1547-2003. These grid support functions may include but are not limited to voltage and frequency ride through and active and reactive power control. These Grid Support Functions may impact an inverter's anti-islanding functionality; therefore Anti-islanding testing will be conducted with these functions enabled as described in the applicable sections below.</p> <p><b><i>New clause added;</i></b></p> <p>As shown in Table SA1.1 the grid support utility-interactive requirements allow for the evaluation of products using either the UL 1741 SA tests or alternative testing methods using the requirements of IEEE 1547.1-2020 in accordance with IEEE 1547-2018 and IEEE 1547a-2020.</p> <p>Note 1: It is anticipated that individual grid interconnection requirements will transition from requiring compliance with UL1741 SA to compliance with the new IEEE 1547.1-2020 in accordance with IEEE 1547-2018 and IEEE 1547a-2020. Allowance for grid support utility-interactive product compliance with either/both requirements will facilitate the transition which will be implemented differently and on different schedules for various jurisdictions.</p> <p>Note 2: An optional path for evaluation of grid support interactive equipment is found in Supplement SB which references full compliance with IEEE 1547.1-2020 in accordance with IEEE 1547-2018 and IEEE 1547a-2020. Some jurisdictions require specific compliance with UL1741 Supplement SA in addition to specific SRD compliance, which is different from the requirements in Supplement SB that uses IEEE 1547-2018 as the functional SRD for testing in accordance to IEEE 1547.1-2020.</p>
SA5	Info	<b>Performance – Grid Support Utility Interactive</b>
SA5.1	Info	<b>General</b>
SA5.1.1		<p><b><i>New clause added;</i></b></p> <p>support functions shall be enabled and set to produce the worst case conditions for the specific test. When performing the abnormal tests in Section 50, consideration shall be given to the worst case EUT grid support interactive operating parameters in the continuous and mandatory operating regions.</p>



CLAUSE	VERDICT	COMMENT
		<b><i>New section added;</i></b>
		<b>Disable Permit Service (Optional)</b>
SA17		<p>These requirements describe the testing used to evaluate the capability of the EUT to respond to a Disable Permit Service / Enter Service Command using IEEE Standard for Smart Energy Profile Application Protocol, IEEE 2030.5-2018, communication protocol.</p> <p>See standard for details.</p>
		<b><i>New section added;</i></b>
		<b>Limit Active Power (Optional)</b>
SA18		<p>These requirements describe the testing used to evaluate EUT response to a Limit Active Power Command using IEEE Standard for Smart Energy Profile Application Protocol, IEEE 2030.5-2018, communication protocol.</p>
<b>The following changes reflect the May 25, 2021 revision</b>		
32	Info	<b>Overcurrent Protection</b>
32.4	Info	<b>Battery circuits</b>
32.4.1		<p>A unit intended for connection to a battery circuit <u>shall have a maximum input short-circuit current rating as required in Table 62.1 and</u> shall be provided with overcurrent protection complying with the requirements described in 32.4.2–32.4.4.</p>
		<b><i>New section added;</i></b>
		<b>Panelboard Features</b>
33		<p>This section covers panelboard features and functions, such as common busses, multiple panel mounted automatic overcurrent devices that are accessible and intended for the control and protection of power and load electrical circuits.</p> <p>See standard for details.</p>



CLAUSE	VERDICT	COMMENT
	Info	<b>PERFORMANCE</b>
44	Info	<b>General</b>
44.2		Unless otherwise specified, the unit is to be energized from a supply that simulates the current-voltage characteristics and time response of the input source. <u>Where the results of a test could be affected by the voltage versus current characteristics and short circuit current capability of the supply, the source is to be adjusted to the maximum rated input voltage of the DUT. The current capability of the test source, measured at the DUT terminals, shall be equal to or greater than the rated maximum input short-circuit current of the DUT.</u> The output of a utility-interactive inverter or converter is to be connected to a supply voltage as specified in 44.3 and Table 44.1.
68	Info	<b>Equipment Information and Instructions</b>
68.2	Info	<b>Operating and installation instructions</b>
		The operating and installation instructions shall:  i) <u>For any chassis mounted power socket or cable mounted power connector not manufactured to a NEMA standard, the following warning and information shall be provided:</u> 1) <u>The following statement: “Any power connector mated with a socket or connector attached to this product must be from the same manufacturer, the same series, and have a matching part number”, and</u> 2) <u>Inverters, microinverters, dc to dc converters and other equipment equipped with PV wiring connectors that comply with the Standard for Connectors for Use in Photovoltaic Systems, UL 6703, shall have the specific allowable mating connector manufacturer(s) and model number(s) listed, as well as contact information and/or website of the PV connector manufacturer. If a specific product is available with multiple PV wiring connectors from various manufacturers, then the following shall be included:</u> i) <u>Means to identify each distinct PV connector manufacturer’s product – such as a picture or illustration, unique physical features, markings, company logos, etc, and</u> ii) <u>Allowable mating connector manufacturer and model number (s) listed for each distinct cable connector manufacturer’s product (s), as well as contact information and/or website of the PV connector manufacturer.</u>
		<b><i>New section added;</i></b>
		<b>Sources and Loads</b>
75		When performing tests on a charge controller using a simulated source for the PV input, the test source is to be adjusted to the maximum rated input voltage, and the current source shall be capable of delivering the DUT’s rated maximum input short-circuit current measured at the DUT terminals.  See standard for details.





CLAUSE	VERDICT	COMMENT
<b>The following changes reflect the June 10, 2021 revision</b>		
32	Info	<b>Overcurrent Protection</b>
32.3	Info	<b>Output ac power circuit overcurrent protection</b>
		<i>New clause added;</i>
32.3.4		Where the unit uses a trunk cable or other output cable to connect multiple units in parallel without an overcurrent device for the output of each unit, the requirements of 32.3.1 and 32.3.2 shall be met for the individual unit and the combined output of all units connected in parallel. The instruction manual shall include the requirements found in 69.4 (U).
69	Info	<b>Important Safety Instructions</b>
		The important safety instructions shall include instructions for the following items A – U. The statement "IMPORTANT SAFETY INSTRUCTIONS", and the statement "SAVE THESE INSTRUCTIONS" shall precede the list. The word "WARNING," "CAUTION," and "DANGER" shall be entirely in upper case letters.
		<b>IMPORTANT SAFETY INSTRUCTIONS</b>
69.4		T. Any device, including a microinverter, PVIE, or string inverter provided with input or output leads or an ac output paralleling cable assembly or a trunk cable that has conductors with stranding finer than Class B or Class C (typically 19 strands for 14-2 AWG conductors), shall include the following statement, or equivalent, in the instruction manual: "The input or output leads or ac output paralleling cable assembly or trunk cable supplied with this device has fine stranded, flexible conductors and if unterminated or if any factory-installed connectors have been removed, shall only be terminated using connections that have been rated for use with such conductors." U. Where the unit uses a trunk cable or other output cable to connect multiple units in parallel without an overcurrent protective device for the output of each unit, the instruction manual for each unit shall include the following statements:  a) Maximum number of units that can be connected in parallel without an overcurrent protective device for each unit. b) The rating of the maximum overcurrent device protecting the combined output circuit of the maximum number of units after the outputs are connected in parallel. c) The minimum ampacity of the conductors in the trunk cable or other cable connected to the output of each unit.



CLAUSE	VERDICT	COMMENT
	Info	<b>CONSTRUCTION</b>
85	Info	<b>General</b>
		<i><b>New clause added;</b></i>
		An AC module that consists of a separate microinverter connected to a PV module with conductors and connectors may be repairable in the field if that repair has been determined to be possible by the original manufacturer or the manufacturer of a suitable retrofit kit. An AC module that can be repaired in the field by replacing the microinverter or the PV module shall comply with the following:
85.15		a) Any mechanical device, threaded or unthreaded, that is used to electrically bond the microinverter to the PV module shall comply with the grounding impedance test of Section 51 after having been removed and reinstalled five (5) times. Bonding shall comply with the requirements in 85.11. b) Any disconnected and exposed (to the environment) connectors attached to the PV module or the trunk cable or other ac output connector shall comply with 85.8 and be provided with protection from the deteriorating effects of the environment, when not connected. c) Any and all input and output connections shall be accessible in the field and be capable of being disconnected using the proper tool without opening the microinverter enclosure or the PV module junction box. Any connectors used or reused shall be mated to connectors from the same manufacturer and series number (mate-ability shall be maintained). The requirements of 85.8 shall be met. d) The manufacturer of the AC module or the manufacturer of the retrofit kit shall identify a suitable replacement microinverter or PV module and provide appropriate replacement instructions if the original equipment microinverter or PV module is no longer available. The retrofit kit shall include detailed instruction and procedures to perform the retrofit installation, including a list identifying all critical components.
	Info	<b>MARKING</b>
90	Info	<b>Details</b>
		<i><b>New clause added;</b></i>
90.7		An AC module, PVIE or other device provided with input or output cables or a trunk cable that has conductors with stranding finer than Class B or Class C (typically 19 strands for 14-2 AWG conductors) shall include the following statement, or equivalent, in the instruction manual: "The input, output or trunk cable supplied with this AC module, PVIE or other device has fine stranded, flexible conductors and if unterminated or if any factory-installed connectors have been removed, shall only be terminated using connections that have been rated for use with such conductors."



CLAUSE	VERDICT	COMMENT
		<b><i>New clause added;</i></b>
90.8		An AC module not evaluated for field repair shall have the word “WARNING” and the following statement, or equivalent, marked on the microinverter and the PV module in a conspicuous location: “Risk of Electric Shock. This AC module has not been evaluated for field repair.”
91	Info	<b>Important Safety Instructions</b>
		<b><i>New clause added;</i></b>
		An AC module that has been evaluated as suitable for field repair shall have the following information in the instruction manual.
91.2		a) Instructions for removing and replacing the microinverter or the PV module, as required, including opening the circuit breaker on the dedicated ac output circuit. b) Instructions for protecting any disconnected and exposed (to the environment) dc and ac connectors. c) Where an identical microinverter or PV module is not available, the manufacturer of the AC module, the manufacturer of the original microinverter or PV module, or the manufacturer of any retrofit kit, shall be queried as to a suitable replacement and for proper instructions for installing that replacement.
		<b><i>New clause added;</i></b>
91.3		An AC module that has not been evaluated for field repair shall have the word “WARNING” and the following statement, or equivalent, in the instruction manual: “Risk of Electric Shock. This AC PV module has not been evaluated for field repair.”
		<b><i>New clause added;</i></b>
91.4		The important safety instructions shall include the instructions required by 69.4(U).
		<b>The following changes reflect the issuing of the 3<sup>rd</sup> edition dated September 28, 2021</b>
Supplement SB		<b>GRID SUPPORT UTILITY-INTERACTIVE INVERTERS AND CONVERTERS BASED UPON IEEE 1547-2018 and IEEE 1547.1-2020</b>
		Supplement SB has been entirely rewritten. See standard for new requirements.