# UL 1977

## STANDARD FOR SAFETY

Component Connectors for Use in Data, Signal, Control and Power Applications

UL Standard for Safety for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977

Fourth Edition, Dated December 7, 2022

***Summary of Topics***

***This new edition of UL 1977 dated December 7, 2022 is being issued to clarify Temperature Test Result Criteria in paragraph 16.1.***

The revised requirements are substantially in accordance with Proposal(s) on this subject dated October 28, 2022.

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# UL 1977

## Standard for Component Connectors for Use in Data, Signal, Control and Power Applications

First Edition – December, 1995
Second Edition – December, 2007
Third Edition – January, 2016

**Fourth Edition**

**December 7, 2022**

This UL Standard for Safety consists of the Fourth Edition.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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## INTRODUCTION

### 1 Scope

1.1 These requirements cover single and multipole connectors, intended for factory assembly to copper or copper alloy conductors or printed wiring boards, for use in data, signal, control and power applications within and between electrical equipment.

1.2 These requirements apply to devices categorized as follows (See Figure 1.1). Type designations used in this Standard only serve as a guide to determine appropriate requirements, and do not represent an assigned rating. A device without an assigned current rating is considered to be either a Type 0 or Type 1A or Type 5 depending upon the assigned voltage rating.

a) Type 0 rated less than 8.3 A and less than 30 V rms (42 V peak);

b) Type 1A rated less than 8.3 A and from 30 V up to and including 600 V ac or dc, or both;

c) Type 1B rated from 8.3 A up to and including 200 A, and less than 30 V rms (42 V peak);

d) Type 2 rated from 8.3 A to less than 31 A and from 30 V up to and including 600 V ac or dc or both;

e) Type 3 rated from 31 A up to and including 200 A and from 30 V up to and including 600 V ac or dc, or both;

f) Type 3A rated from 31 A up to and including 200 A and from 601 V up to and including 1,000 V ac or dc, or both;

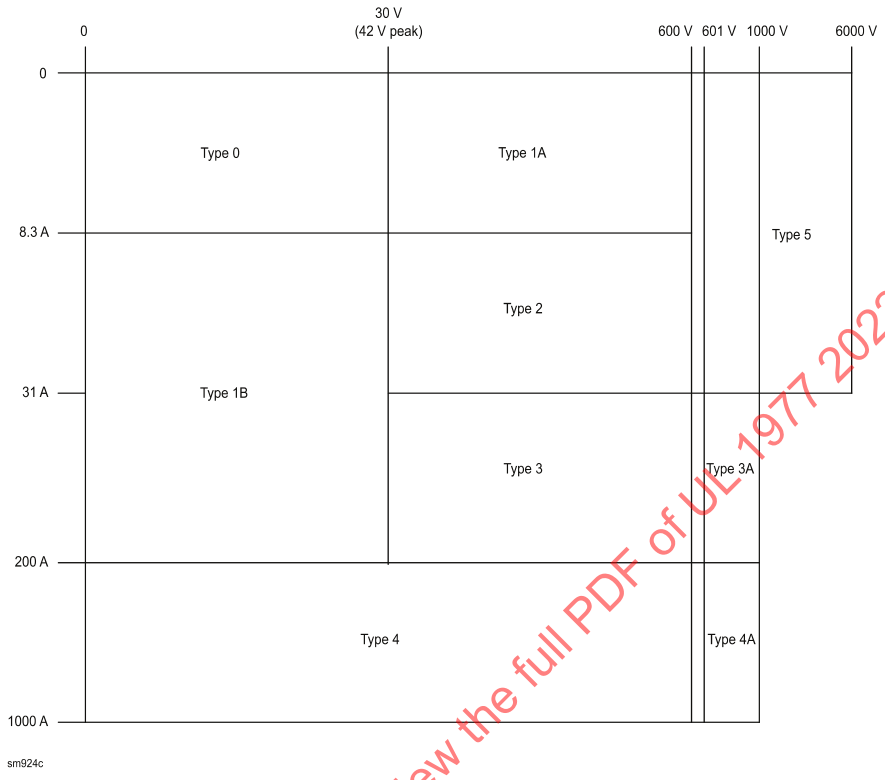
g) Type 4 rated from greater than 200 A up to and including 1,000 A, and up to and including 600 V ac or dc;

h) Type 4A rated greater than 200 A up to and including 1,000 A, and from 601 V up to and including 1,000 V ac or dc; and

i) Type 5 rated less than 31 A and from 601 V up to and including 6,000 V ac or dc, or both.

**Figure 1.1**

**Connector Type Designations**






1.3 This standard does not directly apply to the following devices, but may be used to supplement the requirements within these standards when a device is evaluated to these standards:

a) Devices produced integrally with flexible cord or cable that are covered by the Standard for Cord Sets and Power-Supply Cords, UL 817;

b) Devices intended for connection to the branch circuit, such as attachment plugs, cord connectors, receptacles, inlets, and outlets, that are covered by the Standard for Attachment Plugs and Receptacles, UL 498;

c) Devices solely intended for direct connection to the branch circuit in accordance with the National Electrical Code, NFPA 70, and that are provided with contacts of the pin and sleeve type, that are covered by the Standard for Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type, UL 1682;

d) Devices consisting of wiring terminals and supporting blocks intended for the connection of wiring that are covered by the Standard for Terminal Blocks, UL 1059;

e) Devices intended for use with telecommunications networks, that are covered by the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Communications Circuit Accessories, UL 1863;

f) Devices such as wire connectors and soldering lugs that are covered by the Standards for Wire Connectors, UL 486A-486B; Splicing Wire Connectors, UL 486C; or Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E;

g) Devices such as quick-connect terminals that are covered by the Standard for Electrical Quick-Connect Terminals, UL 310.

1.4 The requirements in this standard may not entirely address all possible situations due to the wide variety of products and designs. In those situations, the Standard for Attachment Plugs and Receptacles, UL 498 may be used to supplement the requirements in this standard. Where a conflict exists between the requirements of UL 498 and UL 1977, the requirements of UL 1977 shall take precedence.

## 2 Glossary

2.1 For the purpose of this Standard, the following definitions apply.

2.2 CONTACT – A conductive element intended to mate with a corresponding element to provide an electrical path.

2.3 ENCLOSURE – The case or housing into which the insulator and contacts are assembled.

2.4 HYBRID DEVICE – A device employing dedicated contacts of two or more type designations.

2.5 INSULATOR – The portion of a device that provides for separation and support of contacts. May be combined with the enclosure.

2.6 TERMINAL – A conductive part provided on a contact for connecting a conductor.

## 3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

3.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

3.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

## 4 Units of Measurement

4.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

## 5 References

5.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

## CONSTRUCTION

### 6 General

6.1 Devices complying with these requirements are acceptable for use as components in an end product where the acceptability of the combination is to be determined.

6.2 The acceptability of a connector in any particular application depends on its ability to be used under the conditions that prevail in actual service. For a particular application, a connector may be affected by the requirements for the equipment in which it is used, and it may be necessary to additionally evaluate features or performance characteristics that are not specified in this standard.

### 7 Insulating Materials

7.1 A base or body in or on which live parts are mounted shall be of porcelain or another insulating material acceptable for the particular application.

7.2 A polymeric material, including rubber compounds, used as an electrical insulator, an internal barrier necessary to maintain spacings, or an enclosure of live parts shall comply with the requirements shown in Table 7.1.

*Exception No. 1: A polymeric material need not have a flame rating for the thinnest measured thickness when the molded connector/material combination complies with the 12 mm or 20 mm (3/4 in) end-product flame tests described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.*

*Exception No. 2: In lieu of a minimum HB flammability rating, small components with an overall volume of less than 2500 $mm^3$ (0.15 $in^3$) may be evaluated and classed with a flammability rating of SC-0, SC-1, or SC-2 in accordance with the Standard for Tests for Flammability of Small Polymeric Component Materials, UL 1694.*

*Exception No. 3: For materials with other than VTM flammability classifications, the flame rating of the material shall be evaluated using the thinnest measured thickness employed in the connector or nominal 1/64 inch (0.4 mm) thickness, whichever is greater.*

7.3 In this requirement, the term "established", when used in reference to material property values, is defined as those values that have been determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B. The polymeric material shall be evaluated using the specimen thickness separating live parts or live parts and grounded metal parts. When the evaluation thickness of the specimen is between two closest thickness values that have been established, the Electrical RTI corresponding to the lower of these two thickness values shall be used. When the evaluation thickness of the specimen is less than the smallest thickness for which a value has been established, the Electrical RTI at the minimum thickness with an established value shall be used. If the material has no established RTI values at any thickness, the generic value for the family of resin to which the material belongs as defined in the section for Relative Thermal Index – Based Upon Historical Record and the Relative Thermal Indices Based Upon Past Field-Test Performance and Chemical Structure table of UL 746B shall be used. When the Mold stress relief, Dielectric voltage-withstand, and the Temperature tests are successfully performed, as required by the desired Type designation and electrical rating(s), the maximum operating temperature of the device may be assigned up to the Electrical RTI value of the polymeric material as determined in this requirement.

**Table 7.1**
**Minimum Ratings for Polymeric Materials**

| Type | Flame rating[a] | Relative thermal index (RTI) Electrical |
|---|---|---|
| 0 | – | 50 |
| 1A | HB | 50 |
| 1B | HB | 50 |
| 2 | HB | 50 |
| 3 | HB | 50 |
| 3A | HB | 50 |
| 4 | HB | 50 |
| 4A | HB | 50 |
| 5 | HB | 50 |

[a] See Exception Nos. 1, 2 and 3 to 7.2.

## 8 Current-Carrying Parts

8.1 Device contacts shall be constructed of plated or unplated copper or copper alloy. Other materials may be accepted if they are found to provide adequate electrical and mechanical characteristics as a result of special investigation.

8.2 Crimp style terminals are considered representative of solder terminals provided the remaining portion of the contacts are identical.

8.3 Iron or steel, whether plain or plated, shall not be used for parts that are depended upon to carry current.

*Exception: Parts that are depended upon to carry current in high temperature applications may be of suitably plated or stainless steel.*

8.4 A current-carrying part shall be secured in place so that turning relative to the surface on which it is mounted would not adversely affect the performance of the device.

8.5 A terminal plate threaded for a wire-binding screw shall meet the following requirements:

a) Be at least 0.76 mm (0.03 in) thick;

b) Thread into metal; and

c) Have at least two complete threads.

In order to obtain two complete threads, the metal of the terminal plate at the tapped hole may be extruded.

8.6 The minimum size for a wire-binding screw shall be as indicated in Table 8.1.

**Table 8.1**
**Minimum Sizes of Wire Binding Screws**

| Rating maximum A | Minimum screw size American No. (metric) | Minimum head diameter, mm (in) |
|---|---|---|
| 15 | 5 (M3) | 6.3 (0.25) |
| 20 | 6 (M3.5) | 7.0 (0.28) |
| 30 | 8 (M4) | 8.3 (0.33) |

## 9 Grounding and Dead-Metal Parts

9.1 Non-current carrying parts of ferrous metal (other than stainless steel), including mounting screws, shall be protected against corrosion by zinc plating, or an equivalent protective coating.

9.2 Dead metal parts of a device provided with a socket contact or terminal identified for use as an equipment-grounding conductor shall be conductively connected to the grounding-conductor path. See Section 21.

9.3 An identified grounding contact, or grounding-conductor path through a device shall be of plated or unplated copper or copper-based alloy.

*Exception No. 1: A metal housing, shell or armor of a device in the path of the identified grounding conductor need not be of copper or copper-based alloy, but shall employ a copper or copper-base alloy contact for connection to the housing of a mating device.*

*Exception No. 2: A device mounting means need not be copper or copper-based alloy.*

*Exception No. 3: Other materials may be acceptable if they are found to provide equivalent electrical and mechanical characteristics as a result of special investigation.*

## 10 Assembly

### 10.1 General

10.1.1 A device shall be capable of being readily installed as intended.

10.1.2 A polarized device incorporating two or more contacts shall be keyed or of such design that the polarization can not be defeated by improper assembly during installation.

10.1.3 Any two or more device parts that may be separated during installation shall not be capable of an assembly that will defeat the intended polarization of wiring.

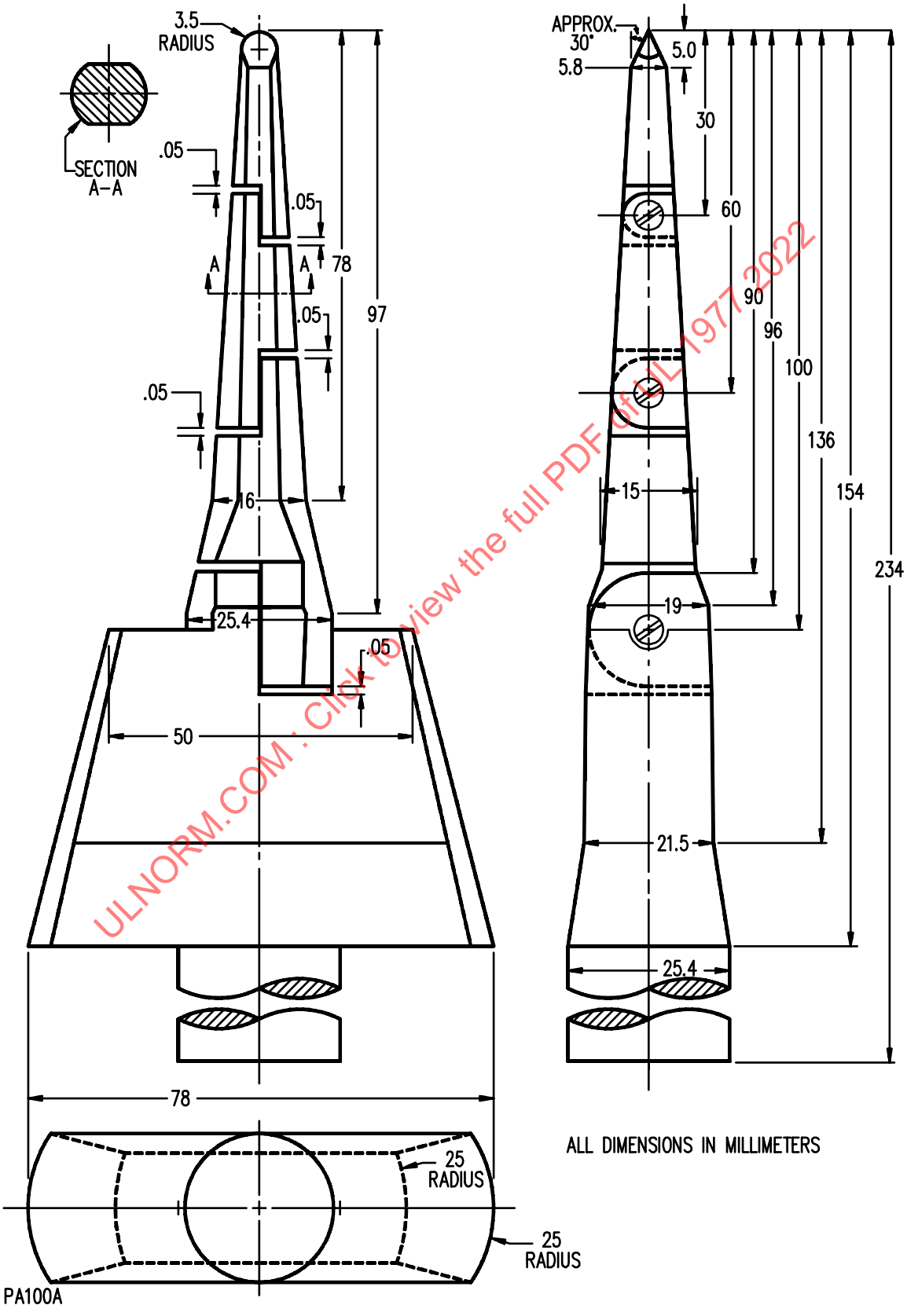
### 10.2 Accessibility of live parts

10.2.1 A connector of Types 1A, 2, 3, 3A, 4, or 4A intended for usage external to the end equipment shall have live parts protected against exposure to contact by persons when assembled, installed and mated as intended, as determined by the use of the probe shown in Figure 10.1.

10.2.2 Mating devices of Types 1A, 2, 3, 3A, 4, or 4A intended for usage external to the end equipment shall not have exposed live contacts during engagement or withdrawal as determined by the use of the probe shown in Figure 10.1.

**Figure 10.1**

**Articulate Probe with Web Stop**



### 10.3 Connection between mating devices

10.3.1 A hybrid device shall be polarized or otherwise constructed so that contacts with different Type designations cannot make electrical contact when mating devices are connected together.

10.3.2 A device provided with an identified grounding contact shall be so constructed that the grounding pin of the corresponding mating device when wired as intended, cannot be inserted into any other opening so as to touch a live contact or other live part.

10.3.3 An identified grounding contact provided on a device shall be located and formed so that the path of electrical continuity to the grounding contact of a mating device is completed before continuity is established between any other contact and its respective contact in the mating device.

*Exception: A Type 0 or 1B device need not comply with this requirement.*

## 11 Spacings

11.1 For devices as specified in Table 11.1 there shall be a minimum spacing through air and over surface of 1.2 mm (3/64 inch) for a device rated 250 volts or less, and a minimum of 3.2 mm (1/8 inch) for a device rated more than 250 volts, between an uninsulated live part and:

a) An uninsulated live part of opposite polarity;

b) An uninsulated grounded metal part; or

c) A non-current carrying metal part that is exposed to contact by persons when the device is installed and used in the intended manner.

*Exception: Spacings less than those specified are permitted if the device complies with the requirements in the Dielectric Voltage-Withstand Test, Section 17.*

**Table 11.1**
**Applicability of Spacing Requirements**

| Type | Uninsulated live part – uninsulated live part of opposite polarity | Uninsulated live part – uninsulated grounded metal part | Uninsulated live part – exposed dead metal part |
|---|---|---|---|
| 0 | No | No | No |
| 1A | Yes | Yes | Yes |
| 1B | Yes | Yes | No |
| 2 | Yes | Yes | Yes |
| 3 | Yes | Yes | Yes |
| 3A | Yes | Yes | hYes |
| 4 | Yes | Yes | Yes |
| 4A | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes |

11.2 Spacings on a Type 3A, 4A and 5 device shall meet the minimum required values for the intended end-use application.

11.3 In measuring a spacing, an isolated dead-metal part interposed between parts under consideration shall be considered to reduce the spacing by an amount equal to the dimension of the isolated dead-metal part in the direction of the measurement.

11.4 Spacings are to be evaluated in all conditions of use, both with and without mating devices of the intended configuration installed and any movable parts displaced to the position of minimum spacings.

## PERFORMANCE

### 12 General

12.1 The performance of devices covered by this Standard shall be investigated by subjecting representative devices in commercial form to the applicable tests described in Sections 13 – 20. Those tests that are required to be performed on each connector Type designation are indicated in Table 12.1.

12.2 Unless stated otherwise, tests are to be conducted on six representative devices with acceptable results.

12.3 Devices employing contacts with different Type designations within a single housing shall be subjected to the tests indicated in Table 12.1 for all applicable Type designations.

**Table 12.1**
**Connector Test Programs**

| Test | Section | Connector type | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Type 0 | Type 1A | Type 1B | Type 2 | Type 3 | Type 3A | Type 4 | Type 4A | Type 5 |
| Accelerated aging | 13 | O | O | O | O | O | O | O | O | O |
| Mold stress relief[a] | 14 | X | X | X | X | X | X | X | X | X |
| Overload[b] | 15 | – | O | O | O | O | N | N | N | N |
| Temperature[b] | 16 | Y | Y | X | X | X | X | X | X | X |
| Dielectric voltage-withstand[b] | 17 | – | X | X | X | X | X | X | X | X |
| Resistance to arcing[b,c] | 18 | – | O | O | O | O | N | N | N | N |
| Conductor secureness | 19 | O | O | O | O | O | O | O | O | O |
| Flammability | 20 | OA | OA | OA | OA | OA | OA | OA | OA | OA |
| Grounding impedance | 21 | O | O | O | O | O | O | O | O | O |

X – Required

Y – Required if device has an assigned current rating.

O – Optional for some devices. Refer to test description for details.

OA – Optional for all devices.

N – Not permitted.

[a] See the Exception to 14.1.

[b] For female devices intended for current interruption the overload, temperature, dielectric voltage-withstand and resistance to arcing tests shall be performed in sequence using the same test specimens.

[c] The resistance to arcing test may be performed on a separate set of specimens. See 18.2.

## 13 Accelerated Aging Test

### 13.1 Rubber compounds

13.1.1 A molded-rubber component shall show no apparent deterioration and shall show no greater change in hardness than ten numbers as the result of exposure for 70 hours in a full-draft circulating-air oven at a temperature of 100.0 ±2.0 °C (212.0 ±1.8 °F).

13.1.2 If possible, the complete device is to be tested. The hardness of the rubber is to be determined prior to testing as the average of five readings with an appropriate gauge such as the Rex Hardness Gauge or the Shore Durometer. The device is to be allowed to rest at room temperature for four or more hours after removal from the oven. The hardness is to be determined again as the average of five new readings. The difference between the average original hardness reading and the average reading taken after exposure to the heat conditioning is the change in hardness.

13.1.3 The accelerated-aging tests mentioned in 13.1.1 and 13.1.2 are to be made on each color of rubber and on each basic rubber compound employed for the device.

### 13.2 PVC compounds

13.2.1 A device having a body of polyvinyl chloride or one of its copolymers shall show no cracks, discoloration, or other visible signs of deterioration as the result of exposure for 96 hours in a full-draft circulating-air oven at a temperature of 100.0 ±1.0 °C (212.0 ±1.8 °F).

*Exception: A device having a body with a hardness of greater than Shore D65 as determined in accordance with ASTM D2240 need not be subjected to this test.*

## 14 Mold Stress Relief Test

14.1 As a result of temperature conditioning as specified in 14.2, there shall not be any warpage, shrinkage or other distortion that results in any of the following:

a) Making uninsulated live parts, other than exposed wiring terminals or internal wiring, accessible to contact by the probe shown in Figure 10.1;

b) Defeating the integrity of the enclosure so that acceptable mechanical protection is not afforded to internal parts of the device;

c) Interference with the operation, function, or installation of the device. The outlet openings of a female device shall be capable of having a mating male device of the intended configuration fully inserted;

d) A reduction of spacing below the minimum acceptable values of 11.1 between an uninsulated live part and:

1) An uninsulated live part of opposite polarity;

2) An uninsulated grounded metal part; or

3) A non-current carrying metal part that is exposed to contact by persons when the device is installed and used in the intended manner.

e) Any other evidence of damage that could increase the risk of fire or electric shock.

*Exception: Devices employing only thermosetting materials are not required to be subjected to this test, including thermosetting elastomeric materials such as neoprene (chloroprene butadiene) rubber (CBR), ethylene/propylene/diene (EPDM), natural rubber (NR), nitrile rubber (NBR), styrene (butadiene) rubber (SBR), and silicone rubber (SIR).*

14.2 Fully assembled, unmated devices are to be placed in a full-draft circulating-air oven for seven hours. The temperature is to be maintained at a uniform temperature of not less than 70 °C (158 °F) and at least 10 °C (18 °F) higher than either of the following:

a) The maximum intended operating temperature of the device, up to the maximum thermal index rating of the insulating material; or

b) The maximum temperature of the connector as measured during the Temperature Test, Section 16.

The devices are to be removed from the oven and allowed to cool to room temperature before determining compliance.

## 15 Overload Test

15.1 A female contact device shall perform acceptably when subjected to an overload test as described in 15.2 – 15.10. There shall not be any electrical or mechanical failure of the device nor pitting or burning of the contacts that would affect the intended function. The grounding fuse shall not open during the test.

*Exception No. 1: A Type 0 device need not be subjected to this test.*

*Exception No. 2: A device that is intended for disconnecting use only, not for current interruption, and is marked in accordance with 23.4, need not be subjected to this test.*

*Exception No. 3: A female contact device interlocked with an integral switch or other means such that the circuit is opened before a mating male contact device can be inserted or withdrawn need not be subjected to this test.*

15.2 Any additional material provided that is intended to reduce or confine the arcing in the contact chamber of the device, and that decomposes or is otherwise affected by the arcing, is to be removed for all of the overload tests.

15.3 A mating device is to be inserted and withdrawn manually or mechanically while connected to a suitable load. The equipment grounding contact is to be connected to ground through a fuse. The device is to make and break 150 percent of its rated current for 50 cycles of operation at a rate not higher than 10 cycles/min. The device is to be mounted and wired to represent actual service conditions. Exposed metal parts and any pole that is not part of the test circuit are to be connected through a fuse to ground or to the grounded conductor of the test circuit.

15.4 The fuse in the grounding circuit is to be a 15 A fuse if the device under test is rated 30 A or lower, and is to be a 30 A fuse if the device under test is rated at more than 30 A. The fuses in the test circuit are not to exceed the ampere rating of the device.

15.5 A previously untested male contact device is to be used for each overload test.

*Exception: One device may be used for all of the overload tests if agreeable to all concerned.*

15.6 Contacts of the device are not to be adjusted, lubricated, or otherwise conditioned before or during the test.

15.7 The potential of the test circuit is to be 95 to 105 percent of the voltage rating of the device.

15.8 A device that has multiple voltage and ampere ratings is to be tested at the following:

a) 150 percent of the rated current that corresponds to the maximum rated voltage;

b) 150 percent of the maximum rated current at the corresponding rated voltage; and

c) 150 percent of the rated current at the corresponding rated voltage that results in the maximum power per pole.

15.9 A test using alternating current may be waived, if acceptable results have been obtained from an equivalent or higher volt-ampere test using a direct current voltage.

15.10 Alternating current is to be used if the device is rated for alternating current only. The power factor of the load is to be 0.75 to 0.80 for an ampere rated device.

## 16 Temperature Test

16.1 The temperature of a device, when measured at the points described in 16.3 shall not exceed the Relative Thermal Index (Electrical) of the insulating material or the maximum intended operating temperature of the device, whichever is less, when the device is carrying its maximum rated current. See 23.2 (b).

*Exception: A Type 0 or Type 1A device not assigned a current rating is not subjected to the temperature test.*

Note: A Type 0 or 1A device with an assigned current rating would be subjected to the temperature test.

16.2 The temperature test shall be performed following the overload test, if applicable, on the same test specimens.

16.3 The temperature measurement mentioned in 16.1 is to be made on the wiring terminals of each device if they are accessible for the mounting of thermocouples. If the wiring terminals are inaccessible, temperatures are to be measured as close as possible to the device current carrying contacts. The test is to continue for 4 hours even if stabilized temperatures are attained in a shorter period of time. A temperature is considered to be stabilized when three consecutive readings, taken at 5 minute intervals, indicate no further rise above the ambient temperature.

16.4 The test shall be conducted using the minimum rated wire size, and maximum number of terminations for the rated current stated in 16.1. Temperatures shall be measured on the wiring terminals of the pole location judged most likely to result in the highest temperatures.

Note: With all poles carrying rated current, the center pole or innermost pole will usually attain higher temperatures than the outer poles.

16.5 Unless otherwise recommended by the manufacturer, all contacts are to be connected in series so as to carry the same test current. For connectors with groups of contacts with different electrical ratings, each group is to be wired as a separate series circuit and tested concurrently.

16.6 This test is to be made in a draft-free area having an ambient temperature of 25 ±5 °C (77 ±9 °F). Tests conducted at an ambient temperature other than 25 °C are to have the test results adjusted to an ambient temperature of 25 °C by adding the appropriate variation between 25 °C and the ambient.