



UL 2238

STANDARD FOR SAFETY

Cable Assemblies and Fittings for Industrial
Control and Signal Distribution

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UL Standard for Safety for Cable Assemblies and Fittings for Industrial Control and Signal Distribution, UL 2238

Third Edition, Dated October 2, 2018

Summary of Topics

This New Edition of ANSI/UL 2238 includes the following changes in requirements:

New Supplement SA – Optional Short Circuit Rated Cable Assemblies and Fittings for Industrial Control and Signal Distribution

Number of Test Samples

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated May 11, 2018.

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**Standard for Cable Assemblies and Fittings for Industrial Control and
Signal Distribution**

First Edition – February, 2009

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Third Edition

October 2, 2018

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The most recent designation of ANSI/UL 2238 as an American National Standard (ANSI) occurred on October 2, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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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SUPPLEMENT SA - Short Circuit Current Rated (SCCR) Cable Assemblies and Fittings for Industrial Control and Signal Distribution

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INTRODUCTION

1 Scope

1.1 These requirements cover devices intended for inter-connection of equipment, sensors, and actuators in remote-control, signaling, and power-limited circuits. Included are cable assemblies and fittings, feeder-tap cable systems, feed-through connectors, multi-outlet fittings, panel-mount fittings, and splitters. These devices are not intended for disconnect means. These devices are rated not more than 60 A and not more than 600 V.

1.2 This standard also contains Supplement SA – Short Circuit Current Rated (SCCR) Cable Assemblies and Fittings for Industrial Control and Signal Distribution.

1.3 Unless otherwise noted, all devices are intended for indoor use.

1.4 These devices are for use on alternating current, direct current, or both.

1.5 The cable assembly fittings and panel-mount fittings are intended to be installed in accordance with the manufacturer's installation instructions. The cable assembly fittings are intended to be assembled or molded on flexible cord.

1.6 Each type of device covered by this standard is described in generic terms where practicable. Reference to use locations identified in the National Electrical Code or specific applications are omitted unless they are required for the identification of the device type. Such additional information is included in the applicable standards for the end-use product involved or in markings for the device.

1.7 This standard does not cover male-to-male cable assemblies.

1.8 This standard does not directly apply to the following but may supplement other applicable 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, covered by the Standard for Plugs, Receptacles, and Cable Connectors, of the Pin and Sleeve Type, UL 1682;

d) Devices intended to interconnect industrial machinery and to be installed in accordance with the Electrical Standard for Industrial Machinery, NFPA 79 that are covered by the Outline of Investigation for Multi-point Interconnection Power Cable Assemblies For Industrial Machinery, UL 2237;

e) Connectors intended for use in Data, Signal, Control and Power Applications within and between electrical equipment and intended for factory assembly as covered by the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977; and the Standard for Telephone Equipment, UL 1459, or the Standard for Communications Circuit Accessories, UL 1863;

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1.9 Fittings and devices that employ surge protective devices and/or circuitry to provide surge protection of internal functionality, in addition to complying with the requirements of this standard, shall also comply with the construction and performance requirements for Type 4 component assemblies or for Type 5 components, as appropriate, in accordance with the Standard for Surge Protective Devices, UL 1449.

1.10 Fittings and devices that are intended to provide surge protection of connected equipment and wiring, in addition to the requirements of this standard, shall also be evaluated to the requirements (including ratings and markings) for either Type 2 or Type 3 (surge protective devices) applications in accordance with the Standard for Surge Protective Devices, UL 1449.

2 Glossary

2.1 For the purpose of this standard the following definitions apply.

2.2 CABLE ASSEMBLY – A length of flexible cord or cable with an male cable fitting as a line fitting and a female cable fitting as a load fitting.

2.3 CORD or CABLE TAG – An adhesive backed label that is wrapped around the cord or cable and secured to itself forming a flag that protrudes from the cord or cable. A label without adhesive that is secured to the cord or cable using a securement strap such as a cable tie is also consider a cord tag.

2.4 CURRENT-CARRYING CONDUCTOR – A cord conductor excluding both the grounding conductor and the neutral conductor.

2.5 ENCLOSURE – That part of the device that renders inaccessible all or any parts of the device that otherwise present a risk of electric shock, propagate of flame initiated by electrical disturbances occurring within, or both.

2.6 FEEDER-TAP CABLE SYSTEM – A connector provided with field-wiring terminals for feed-through connection to power-limited tray cable or other appropriate cable and either a female connector to connect to a cable assembly or field-wiring terminals to connect to flexible cord.

2.7 FEED-THROUGH CONNECTOR – A male and female device directly connected through the pins or contacts. This device is not assembled on a cable or conductor.

2.8 FEMALE CABLE FITTING – A female contact device intended to be molded or assembled to flexible cord to make an electrical connection to a male cable fitting or an inlet.

2.9 GROUNDED CONDUCTOR – The circuit conductor that is intentionally grounded.

2.10 GROUNDING-CONDUCTOR PATH – A path between the grounding pin or contact and the grounding terminal.

2.11 INLET – A male contact device intended to be mounted on equipment where the conductors are internal to the equipment to provide an integral means for the connection of a female cable fitting.

2.12 INSULATION, BASIC – Insulation applied to live parts to provide basic protection against a risk of electric shock. This insulation does not necessarily include insulation used exclusively for functional purposes.

2.13 INSULATION, FUNCTIONAL – The insulation necessary for the proper functioning of the fitting and for basic protection against a risk of electric shock. This includes all parts relied upon to support live parts in place, all internal barriers necessary to maintain spacing, and the outlet face portion of all female fittings.

2.14 MALE CABLE FITTING – A male contact device intended to be molded or assembled to a flexible cord or cable to make an electrical connection to a female panel-mount fitting, a female cable fitting, or outlet.

2.15 OUTLET – A female contact device intended to be mounted on equipment where the conductors are internal to the equipment to provide an integral means for the connection of a male cable fitting.

2.16 POLARIZED DEVICE – A device constructed for connection to a mating fitting only in the position that connects related poles of an electrical circuit.

2.17 SMALL PARTS – A small part is considered to be not more than 0.122 in³ (2 cm³) in volume.

2.18 SPLITTER – A male fitting that terminates in two or more outlets or that terminates in two or more female cable fittings.

2.19 TERMINAL, INSULATION-DISPLACEMENT – A terminal having a contacting member that forces the conductor insulation aside and presses to contact the current-carrying conductor.

2.20 TERMINAL, PIN TYPE (INSULATION-PIERCING) – A terminal having a contact pin that punctures the conductor insulation to contact the current-carrying conductor.

2.21 TERMINAL, PRESSURE WIRE – A terminal that establishes a connection between one or more conductors and a terminal plate by means of mechanical pressure without the use of solder. The terminal is one of the following types:

a) Clamp-type – A terminal in which the conductor is held under a pressure plate or saddle clamp by one or more screws. This type of terminal may be provided in combination with a wire-binding screw terminal.

b) Setscrew-type – A terminal in which the pressure is applied by the end of the screw bearing on the conductor, either directly or through a wire-protecting pad.

2.22 TERMINAL, WIRE-BINDING SCREW – A terminal in which the conductor is bent around the screw and is clamped directly under the head of the screw when it is tightened.

2.23 TERMINAL, CRIMP TYPE – A terminal in which an electro-mechanical connection is made between the terminal lug and a conductor by compressing the lug onto the conductors.

2.24 UNIT CONTAINER – The smallest carton, package, or container, in which a fitting is packaged. A unit container may contain more than one fitting if the devices are not intended to be removed from the container for individual sale.

2.25 VALVE FITTING – A male or female fitting contact device intended to be molded or assembled to a flexible cord or cable or assembled to conduit and is intended to be connected or assembled to a valve.

2.26 WRAP AROUND CORD or CABLE LABEL – An adhesive backed label that wraps around the cord or cable and adheres to the cord or cable itself or the wrap around label.

3 References

3.1 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.

4 Components

4.1 Except as indicated in 4.2, 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.

4.2 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.

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

4.4 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.

5 Units of Measurement

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

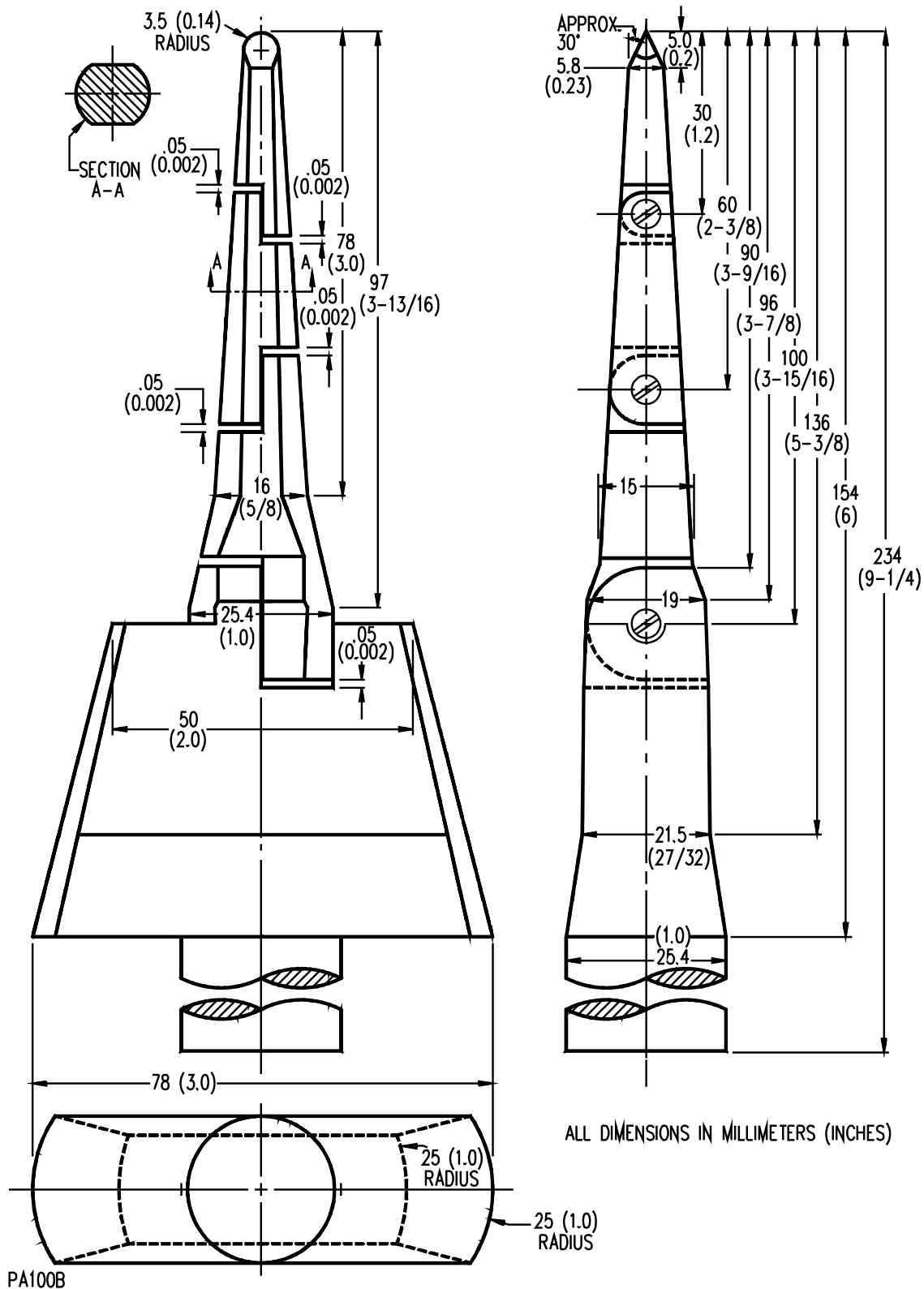
CONSTRUCTION

6 Accessibility of Uninsulated Live Parts

6.1 General

6.1.1 Uninsulated live parts, other than exposed wiring terminals, and internal wiring shall not be accessible to contact by the probe illustrated in Figure 6.1. The probe is to be applied with a force of 3 lbf (13.3 N). The probe is to be rotated, changed in configuration, or angled; before, during, and after application.

Figure 6.1
Accessibility probe



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6.1.2 The probe is to be used as a measuring instrument to investigate the accessibility and not as an instrument to determine the strength of a material.

6.2 Valve fittings

6.2.1 Valve connectors shall comply with the requirements in 7.4, Sections 6 and 8 – 17.

6.2.2 A polymeric material used for the enclosure of a valve fitting shall have a flammability classification of 5 VA in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The flame class rating of the material shall be determined at the minimum thickness employed at the walls in the device which are critical to the functioning of the enclosure of the device.

Exception: A polymeric material used for the enclosure of a valve fitting is acceptable if the material is rated a minimum of HB and complies with the end product Flammability – 127 mm (5 inch) Flame Test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.2.3 A polymeric material used for electrical insulation shall comply with the requirements specified in the Standard for Polymeric Materials-Used in Electrical Equipment Evaluation, UL 746C and be suitable for direct support of live parts.

7 Insulating Materials

7.1 General

7.1.1 A part that functions as electrical insulation or as an enclosure of a device shall be made of insulating material rated for the particular application.

7.1.2 Vulcanized fiber shall not be used as the sole support of live parts. Vulcanized fiber is acceptable for insulating washers, separators, and barriers. Vulcanized fiber shall comply with Moisture Absorption Resistance Test, Section 20.

7.1.3 Tubing used to enclose live parts shall have a flammability rating of VW-1 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The tubing shall be rated for voltage and temperature for the conditions of use.

7.2 Flammability

7.2.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a flammability classification of HB, V-2, V-1, V-0, VTM-2, VTM-1, VTM-0, 5VA, or 5VB in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. The flame class rating of the material shall be determined at the minimum thickness employed at the walls and barriers in the device which are critical to the functioning of the insulation or enclosure of the device.

Exception No. 1: This requirement does not apply to a small part:

- a) With a volume that does not exceed 0.122 in³ (2 cm³),*
- b) With no dimension exceeding 1.18 in (3 cm), and*
- c) That is located such that the part does not propagate flame from one area to another or act as a bridge between a source of ignition and other ignitable parts.*

Exception No. 2: This requirement does not apply to fiber or similar material that is 0.010 in (0.25 mm) or less thick.

Exception No. 3: A material that has been subjected to the horizontal or vertical burning test (bar sample testing) as described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, need not have a flame rating.

Exception No. 4: This requirement does not apply to devices rated 8 A or less and 30 V_{rms} (42 V_{peak}) or less when marked in accordance with 40.1.12.

Exception No. 5: A polymeric material need not have a flame rating for the thinnest measured thickness when the molded material 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.

7.3 Electrical properties

7.3.1 General

7.3.1.1 A polymeric material used for electrical insulation or enclosure of live parts shall comply with 7.3.2, 7.3.3, and 7.3.4.

Exception No. 1: The requirements in 7.3.2, 7.3.3, and 7.3.4 do not apply to devices rated 8 A or less and 30 V (42 V_{peak}) or less.

Exception No. 2: Small parts that are made from polymeric or epoxy type materials that do not come into contact with live parts or are totally encapsulated due to their design and do not track between parts of opposite polarity and/or any other uninsulated metal parts of different polarities do not have to comply with the requirements of 7.3.2, 7.3.3, and 7.3.4. A small part is considered to be not more than 0.122 in³ (2 cm³) in volume.

7.3.2 Comparative tracking index (CTI)

7.3.2.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a comparative tracking index (CTI) performance level category (PLC) rating of 0, 1, 2, or 3 determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception No. 1: A polymeric material used in over-mold applications to form the enclosure of live parts or within contact with live parts not to exceed 0.039 inch (1 mm) in length shall not require a comparative tracking index (CTI) rating.

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirements if it complies with the Comparative Tracking Index (CTI) Test in Section 35.

7.3.3 Hot wire ignition (HWI)

7.3.3.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a hot wire ignition (HWI) performance level category (PLC) rating not less than specified in Table 7.1 determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. For a material with other than a VTM flammability classification, the acceptability of the material shall be determined using the material thickness employed in the end-use product or a nominal 1/8-in (3.2-mm) thickness, whichever is greater. (The minimum thickness employed in the device which is critical to the functioning of the insulation of live parts.)

Exception No. 1: This requirement does not apply to:

- a) A polymeric material used in an enclosure of an attachment plug or cord connector, or*
- b) A polymeric material that encloses insulated live parts with an insulation thickness greater than 0.025 in (0.5 mm).*

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirements if it complies with the Glow Wire Test in Section 36.

Table 7.1
Hot-wire ignition (HWI) ratings

Flammability classification ^a	HWI ^b	
	Mean ignition time ^c s	PLC ^d
V-0, VTM-0	7 and up to 15	4
V-1, VTM-1, 5VA, 5VB	15 and up to 30	3
V-2, VTM-2	30 and up to 60	2
HB	30 and up to 60	2
^a Flammability classification – Determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. ^b HWI – Hot wire ignition (HWI) determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. ^c Mean ignition time is to be used to determine the acceptability of filament wound tubing, industrial laminates, vulcanized fiber, and similar polymeric materials only. All other materials are to be investigated using the performance level category values. ^d PLC – performance level category.		

7.3.4 High-current arc ignition (HAI)

7.3.4.1 A polymeric material used for electrical insulation of live parts shall have a high-current arc ignition (HAI) performance level category (PLC) rating not less than specified in Table 7.2 as determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. For a material with other than a VTM flammability classification, the acceptability of the material shall be determined using the material thickness employed in the end-use product or a nominal 1/8-in (3.2-mm) thickness, whichever is greater.

Exception No. 1: This requirements does not apply to:

- a) A polymeric material used in over-mold applications to form the enclosure of live parts, and*
- b) A polymeric material used within contact with live parts not to exceed 0.039 inch (1 mm) in length.*

Exception No. 2: A polymeric material used for electrical insulation or enclosure of live parts is not required to comply with this requirements if it complies with the High-Current Arc Resistance to Ignition Test in Section 37.

Table 7.2
High-ampere arc ignition (HAI) ratings

Flammability classification ^a	HAI ^b	
	Mean number of arcs ^c s	PLC ^d
V-0, VTM-0	15 and up to 30	3
V-1, VTM-1, 5VA, 5VB	30 and up to 60	2
V-2, VTM-2	30 and up to 60	2
HB	60 or more	1
^a Flammability classification – Determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. ^b HAI – High-current arc ignition (HAI) determined in accordance with Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. ^c Mean number of arcs is to be used to determine the acceptability of filament wound tubing, industrial laminates, vulcanized fiber, and similar polymeric materials only. All other materials are to be investigated using the performance level category values. ^d PLC – performance level category.		

7.4 Thermal properties

7.4.1 A polymeric material used for electrical insulation or enclosure of live parts shall have a relative thermal index (RTI) rating as specified in Table 7.3. For a material with other than a VTM flammability classification, the acceptability of the material shall be determined using the material thickness employed in the end-use product or a nominal 1/8-in (3.2-mm) thickness, whichever is greater.

Exception No. 1: If the polymeric material does not have a RTI value, see the Relative Thermal Indices Based Upon Past Field-Test Performance and Chemical Structure table (Table 7.1) in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, for generic RTI values.

Exception No. 2: The following generic materials having readings of 65 or less on the Shore Durometer D scale (when measured for 5 s at an ambient temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$)) are acceptable for use at 60°C (140°F) based on their successful completion of the appropriate accelerated aging test described in Accelerated Aging Tests, 37.5:

- a) Ethylene/Propylene/Diene (EPDM);*
- b) Natural Rubber (NR);*
- c) Neoprene (Chloroprene Butadiene) Rubber (CBR);*
- c) Nitrile Rubber (NBR);*
- e) Polyvinyl Chloride (PVC) and its copolymers;*
- f) Styrene (Butadiene) Rubber (SBR); and*
- g) Thermo Elastomeric [TEE; includes Thermoplastic Elastomers (TPE) and Ethylene Propylene Thermoplastic Rubber (EPTR)].*

Table 7.3
Minimum relative thermal indices (RTI)

Application	Minimum RTI ^a		
	Electrical °C (°F)	Mechanical with impact ^b °C (°F)	Mechanical without impact °C (°F)
Permanently-wired devices (cable assemblies, panel-mounted fittings, multi-outlet fittings, or feeder-tap cable systems)	50 (122)	50 (122)	50 (122)
Cable assemblies (including male cable fitting, female cable fitting, multi-outlet fittings, splitters, and feed-through connectors)	50 (122)	50 (122)	50 (122)
^a RTI – The relative thermal index determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B or the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C. ^b For industrial laminates, vulcanized fiber, and similar polymeric materials, the material's minimum RTI for mechanical with impact shall comply with the values specified for mechanical without impact.			

8 Live Parts

8.1 Iron or steel, plated or unplated, shall not be used for a current-carrying part. Stainless steel is acceptable for a current-carrying part that is not subject to arcing.

8.2 A current-carrying part shall be restrained from turning relative to the surface on which the part is mounted if such turning affects the performance of the device.

8.3 Uninsulated live parts shall be secured in place so that the spacings are not reduced below those specified in 12.1.

9 Grounding and Dead-Metal Parts

9.1 The following grounding parts shall be copper or a copper-base alloy:

- a) A grounding pin or contact, and
- b) Parts that are in the grounding path in a male cable fitting, multi-outlet fitting, splitter, feed-through connector, or female cable fitting.

Exception: Fastening devices, such as coupling nuts or assemblies used to connect shielded cables, as part of the grounding path may be composed of other materials, such as zinc, so long as the interface resistance is below 25 mΩ.

9.2 Steel or its equivalent is acceptable for a rivet, bolt, or clamp that is used to secure parts in the grounding path if the rivet, bolt, or clamp is not a conductor in the grounding path.

9.3 A copper-base alloy rivet that is used to secure parts in the grounding path, or that forms a part of the grounding path, shall not contain less than 80% copper.

9.4 The requirements in 9.1 – 9.3 apply to the entire grounding-conductor path between the grounding pin or contact and the grounding terminal.

9.5 Grounding parts and dead-metal parts shall be secured in place so that the spacings are not reduced below those specified in 12.1.

9.6 A dead-metal part of a grounding device shall be conductively connected to the grounding-conductor path by means of the device unless the dead-metal part is isolated from current-carrying parts and wiring other than a complete flexible cord. A flexible cord is not complete if two insulated conductors of a parallel-type cord are split apart or where the jacket of a jacketed-type cord is removed from the insulated conductors.

9.7 A dead-metal part of a device for use in a non-grounding application where there is no provision for grounding the dead-metal part shall be insulated from live parts and wiring other than a complete flexible cord so that stray strands, malfunction of wiring terminals, or malfunction of wiring does not energize accessible dead-metal parts. A flexible cord is not complete if two insulated conductors of a parallel-type cord are split apart or where the jacket of a jacketed-type cord is removed from the insulated conductors.

9.8 For a grounding device, the pin that is to be used for grounding shall be longer than the other pins. The male cable fitting shall be constructed such that, when it is inserted into its corresponding female cable fitting, contact between the grounding pin and the corresponding grounding terminal contact will be made before contact between the other pins and their corresponding contacts.

10 Terminals

10.1 When a device is intended for connection by conductors, the means for connection shall be one of the following:

- a) A wire-binding screw,
- b) A factory assembled conductor attached by means of soldering, welding, riveting, or crimping, or
- c) A terminal wire connector that utilizes positive screw pressure on a bared conductor or spring action type terminal.

Exception No. 1: A terminal wire connector that utilizes spring action or positive screw pressure for retaining the conductor connection may be employed provided it complies with the performance requirements in the Test Sequence for All Wiring Terminals table, Sequence 1, 2, and 3 in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E. A factory wiring terminal need not comply with the mechanical sequence, but shall comply with 10.10.

Exception No. 2: Terminal block type devices will be subjected to the requirements in the Table for Test Sequences for All Connectors, Sequence 3, in the Standard for Terminal Blocks, UL 1059. See 10.9.

10.2 A terminal wire connector that utilizes spring action for retaining the grounding terminal shall additionally comply with the Grounding (Bonding) Path Current Test specified in 37.3.

10.3 Each conductor shall be fastened to the terminals of fittings in a manner that:

- a) Prevents strands of any conductor from contacting uninsulated live parts of opposite polarity or dead-metal parts,
- b) Provides mechanical security in accordance with Conductor Secureness Test, Section 23,
- c) Provides ampacity for compliance with Temperature Test, Section 25, and
- d) Prevents strands from surfacing in a molded-on fitting.

10.4 A setscrew type terminal shall not be employed in other than a pressure wire connector as specified in 10.8.

10.5 A wire-binding screw shall thread into metal. The thickness of the metal shall provide two full threads for the screw.

Exception: A wire-binding screw that has 32 or more threads per 1 in (25.4 mm) with a terminal plate formed from stock 0.030-in (0.76-mm) thick is acceptable if the metal of the plate is extruded at the tapped hole to provide two full threads for the screw.

10.6 The minimum size for a wire-binding screw shall be as indicated in Table 10.1.

Table 10.1
Minimum sizes of wire-binding screws

Maximum terminal current A	Minimum screw size No. (metric)	Maximum number of threads per inch
15	5 (M3)	36
20	6 (M3.5)	32
30	8 (M4)	32

10.7 A direct-bearing, setscrew pressure wire connector shall comply with the applicable requirements in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

10.8 The tightening torque for a field-wiring terminal shall be specified by the device manufacturer and the device shall be marked in accordance with 40.1.8. The tightening torque shall not be less than 90% of the value required for the Static Heating Test in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E, for the maximum wire size corresponding to the ampere rating of the device.

Exception: A lesser torque value meets the intent of the requirement if the connector complies with the Standard for Wire Connectors, UL 486A-486B, or the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E, using the lesser torque value.

10.9 If a spring-force type terminal block is employed in a device, it shall be subjected to the requirements in the Standard for Terminal Blocks, UL 1059 (see Part III – Spring Force Connections, columns A, B, C of the Sequence of Tests for Terminal Blocks Having Spring Force Connections Table).

10.10 A terminal block having spring force connections rated for factory wiring only shall be subjected to this test in lieu of the Secureness and Pullout Test in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E. Previously unused samples of the spring force connection are to be subjected to a gradual tensile pull force. Four samples, each of the minimum and maximum rated wire size and type, are to be assembled as intended. The force to cause displacement shall be recorded.

11 Strain Relief and Cord Entries

11.1 A strain-relief means shall be provided in a device intended for connection to a flexible cord so that a pull on the flexible cord is not transmitted to the binding-screw terminals, or connection between the conductors and the pins or contacts as determined in accordance with Strain-Relief Test, Section 24.

11.2 The cord-entry hole for a flexible cord in a metal enclosure shall be provided with an insulating bushing of porcelain, phenolic, cold-molded composition, or other insulating material with equivalent properties.

12 Spacings

12.1 Through air and over surface spacing shall not be less than 3/64 in (1.2 mm) for a device rated 250 V or less, and not less than 1/8 in (3.2 mm) for a device rated more than 250 V:

- a) Between uninsulated live parts of opposite polarity, and
- b) Between an uninsulated live part and a dead-metal part that is to be grounded or that is exposed to contact by persons when the device is installed as intended.

Exception: Spacings less than those specified meet the intent of the requirement if the device complies with the Dielectric Voltage-Withstand Test, Section 21.

12.2 With reference to 12.1(b), dead metal includes a metal surface on which the device is mounted. A dead-metal screwhead, rivet, or a similar part is not exposed to contact by persons where, after the device is installed in the intended manner, the dead metal is located in a hole not larger than 9/32 inch (7.1 mm) in diameter and recessed not less than 3/16 inch (4.8 mm) in the clear.

13 Assembly

13.1 General

13.1.1 An assembled-on or panel-mounted device shall be easily wired as intended so that the wires are not damaged.

13.1.2 Electrical contact shall be reliably maintained at any point at which a connection is made between current-carrying parts.

13.1.3 A live part of an outlet or cord connected device shall be protected against exposure to contact by persons when the device is assembled and installed as intended.

13.1.4 Where internal connections exist in a multi-outlet device, similar and corresponding contacts of individual outlets shall be connected together.

13.1.5 A device having female contacts shall be constructed so that a mating male cable fitting seats without exposure of the contacts of the male cable fitting between the plane of the face of the male cable fitting and the plane of the rim of the female cable fitting device.