

UL 1472

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Solid-State Dimming Controls

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UL Standard for Safety for Solid-State Dimming Controls, UL 1472

First Edition, Dated January 2, 1996

Revisions: This Standard contains revisions through and including June 19, 2006.

Summary of Topics

The revisions dated June 19, 2006 were issued to:

- 1. Clarify the scope with respect to ratings and uses for dimmers***
- 2. Update references for requirements for cover plates for flush-mounted dimmers***
- 3. Clarify markings for dimmers with respect to air-gap switches, electronic ballasts, electronic transformers, and location of model and catalog numbers***
- 4. Clarify the use of a synthetic load in place of a magnetic ballast***
- 5. Add requirements for electronic transformers for low voltage incandescent lighting***
- 6. Clarify the acceptance criteria for the Air-Gap Switch Test***
- 7. Update wording for consistency and clarification reasons***

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Text that has been changed in any manner is marked with a vertical line in the margin.

The new requirements are substantially in accordance with UL's Proposal(s) on this subject dated September 23, 2005 and March 17, 2006.

The revisions dated June 19, 2006 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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First Edition

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First Edition



Solid-State Dimming Controls

January 2, 1996

(Title Page Reprinted: June 19, 2006)



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Commitment for Amendments

This Standard is issued jointly by Canadian Standards Association and Underwriters Laboratories Incorporated. Amendments to this Standard will be made only after processing according to the Standards writing procedures by both Canadian Standards Association and Underwriters Laboratories Incorporated.

The most recent designation of ANSI/UL 1472 as an American National Standard (ANSI) occurred on June 16, 2006 and covers the first edition including revisions through June 19, 2006. The ANSI approval does not include the Cover Page, Transmittal, Title Page, Appendix A, or Appendix B. Approval of ANSI/UL 1472 as an American National Standard is maintained using the continuous maintenance process. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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Appendix B

French translations and markings

Preface

This is the common UL and CSA Standard for Solid-State Dimming Controls. It is the first edition of both CSA-C22.2 No. 184.1-96 and UL 1472.

This common Standard was prepared by a Task Force comprised of members representing CSA, UL, NEMA (National Electrical Manufacturers Association) and the EFC (Electro-Federation of Canada).

This standard includes all items presently covered in C22.2 No. 184-M1988 except the following:

- a) Lighting controls without integral switching (disconnecting control).
- b) Devices used as table mounted unit to which a portable luminaire can be temporarily connected.
- c) Devices installed in lampholders.
- d) Devices permanently installed in the supply line of a lamp.
- e) Direct plug-in devices.

The above will be accommodated either in a new edition of C22.2 No. 184, or in future revisions of this standard.

Note: *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

Level of Harmonization

This Standard is published as an identical standard for UL and CSA.

An identical standard is a standard that is the same in technical content except for conflicts in Codes and Governmental Regulations. Presentation shall be word for word except for editorial changes.

Interpretations

The interpretation by the SDO of an identical or equivalent standard shall be based on the literal text to determine compliance with the standard in accordance with the procedural rules of the SDO. If more than one interpretation of the literal text has been identified, a revision shall be proposed as soon as possible to each of the SDOs to more accurately reflect the intent.

UL Effective Date

As of May 26, 2006 all products Listed or Recognized by UL must comply with the requirements in this Standard.

CSA Effective Date

The effective date for CSA will be announced through CSA Informs or CSA Certification Notice.

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Solid-State Dimming Controls

1 Scope

1.1 These requirements cover permanently installed devices, hereafter referred to as dimmers, that employ a dimming function intended for control of lighting loads of the ballast, transformer, or tungsten-filament type, and are intended to be installed in a wallbox or are provided with an enclosure for flush or surface mounting in accordance with the Canadian Electric Code, Part 1 (CEC), and the National Electrical Code (NEC), ANSI/NFPA 70.

1.2 These requirements cover dimmers, other than touch dimmers, rated 600 volts ac or less, for installation on a 20-ampere or less branch circuit.

1.2A These requirements cover touch dimmers rated 120 volts ac or less for installation on a 20-ampere or less branch circuit.

1.3 These requirements cover dimmers, including touch dimmers, and electronic switches, having a minimum power rating of 300 watts or 300 volt-amperes in increments of 50 watts or 50 volt-amperes.

1.4 A device incorporating other functions (for example, speed control) in addition to a dimming function is investigated on the basis of compliance with the applicable requirements for the dimming function in this Standard as well as requirements for the other functions in the applicable standards.

1.5 These requirements do not cover dimmers that use only a resistor or a transformer to perform the dimming function.

1.6 These requirements do not cover modular, cabinet or console type constructions.

1.6A These requirements do not cover dimmers intended primarily for use in theaters. Dimmers for use in theaters are covered by the Standard for Industrial Control Equipment, UL 508/CSA C22.2 No. 14.

1.7 *deleted June 19, 2006.*

2 Definitions

2.1 The following definitions apply in this Standard.

Actuating member – Part of the operating mechanism that is used for the dimming control functions. This member may also be used to operate the air-gap switch.

Dimmer – A device intended to change lighting to various intensities. For the purposes of these requirements, the term “dimmer” refers to all products covered by this Standard.

Electronic switch – A solid-state device that performs strictly an on-off function and meets the requirements of this standard including the air-gap switch requirement.

Off position – The air-gap switch is in the open position.

Opposite polarity – A difference of potential between two points where shorting of these two points would result in a condition involving overload, rupturing of printed wiring board tracks, components, fuses, or the like.

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Touch dimmer – A device using circuitry for touch actuation in accordance with Clauses 4.9 and 5.13. Examples of such circuitry are non-isolated sensing or conductively connected dead metal.

Type I dimmer – A dimmer in which the air-gap switch is used to energize preset lighting levels.

Type II dimmer – UL A dimmer with an air-gap switch that opens and closes the load circuit at the minimum output voltage setting only.

Type IIa dimmer – A dimmer with an air-gap switch that opens and closes the load circuit at the maximum output voltage setting only.

Type III dimmer – A dimmer incorporating solid-state components providing preestablished rectified output settings.

Type IV dimmer – A dimmer not covered by Types I – III.

3 General requirements

3.1 Components

3.1.1 Except as indicated in Clause 3.1.2, 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 generally used in the products covered by this Standard. A component shall comply with both the Underwriters Laboratories Inc. and Canadian Standards Association Standards for the component.

3.1.2 A component need not comply with a specific requirement that:

- a) involves a feature or characteristic not needed in the application of the component in the product covered by this Standard, or
- b) is superseded by a requirement in this Standard.

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

3.1.4 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.

3.2 Normative references

3.2.1 Where reference is made to other publications, such reference shall be considered to refer to the latest edition and all amendments published to that edition up to the time when this Standard was published:

UL Standards

Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances,
UL 94

Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors,
UL 486A

Standard for Wire Connectors for Use With Aluminum Conductors,
UL 486B

Standard for Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors,
UL 486E

Standard for Metallic Outlet Boxes,
UL 514A

Standard for Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers,
UL 514C

Standard for Polymeric Materials – Long Term Property Evaluations,
UL 746B

Standard for Polymeric Materials – Use in Electrical Equipment Evaluations,
UL 746C

Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment,
UL 840

Standard for Across-the-Line, Antenna-Coupling, and Line-By-Pass Capacitors for Radio-and-Television-Type Appliances,
UL 1414

CSA Standards

C22.2 No. 0.17,
Evaluation of Properties of Polymeric Materials

C22.2 No. 18-92,
Outlet Boxes, Conduit Boxes and Fittings

C22.2 No. 65-93,
Wire Connectors

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3.2.2 This Standard refers to the following publications and where such reference is made it shall be to the edition listed below.

ANSI Standards

ANSI MC96.1-1982,
Temperature Measurement Thermocouples

ANSI/NFPA 70-1993,
National Electrical Code (NEC)

CSA Standards

C22.1-1994,
Canadian Electrical Code, Part 1

3.3 Units of measurement

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

4 Construction

4.1 Polymeric materials

4.1.1 A polymeric material used for electrical insulation or as an enclosure part shall have a flammability class rating of 5VA, 5VB, V-0, V-1, or V-2 in accordance with UL 94 and C22.2 No. 0.17. The flammability class rating shall be investigated at the nominal minimum thickness of a polymeric material used within 0.8 mm (1/32 inch) of uninsulated live parts.

Exception No. 1: A polymeric material that complies with either the 12 mm or 3/4 inch flame flammability test described in UL 746C and C22.2 No. 17, need not have a flammability class rating.

Exception No. 2: If the polymeric material is not used in place of the spacings specified in Table 4, a polymeric material used in a rear housing totally contained within the volume of the outlet box may have a minimum flammability class rating of HB.

4.1.2 A polymeric material used for electrical insulation or as an enclosure part shall have a performance level category (PLC), determined in accordance with UL 746C, that complies with the requirements specified in Table 1 for electrical insulation or Table 2 for enclosure parts, respectively.

Exception No. 1: A polymeric material that complies with the requirements in UL 746C is considered to comply with both Table 1 and Table 2.

Exception No. 2: If the spacings to a polymeric material used as an enclosure part are not greater than the through-air and over-surface spacings specified in Table 4, the polymeric material shall comply with both Table 1 and Table 2.

Exception No. 3: If the polymeric material is not used in place of the spacings specified in Table 4, a polymeric material that does not contact uninsulated live parts and that is used as a rear housing totally contained within the volume of the outlet box need not comply with the performance level categories.

4.1.3 A polymeric material used as electrical insulation or as an enclosure part shall have the minimum relative thermal index (RTI) rating specified in Table 3. Higher ratings may be required in a specific application based on the results obtained for the temperature test, Clause 5.5.

4.1.4 A thermoplastic part shall comply with the mold stress-relief test, Clause 5.12.

4.2 Actuating member

4.2.1 An actuating member shall have the strength necessary to resist the abuses to which it is likely to be subjected in its intended use, and shall be securely attached to the operating mechanism that it is intended to control.

4.2.2 An actuating member of conductive material shall be insulated from live parts.

4.3 Spacings

4.3.1 The minimum through-air and over-surface spacings maintained between uninsulated live parts of opposite polarity, and between an uninsulated live part and a grounded or dead metal part, other than a metallic flush cover plate that is intended to be grounded or exposed to contact when the dimmer is installed in the intended manner, shall be as specified in Table 4. Spacings are to be investigated with 12 AWG (3.3 mm²) wire connected to the field wiring terminals.

Exception No. 1: When a printed-wiring board is conformally coated with a material that complies with the conformal-coating test requirements specified in UL 746C and CSA C22.2 No. 017, the spacings between uninsulated live parts of opposite polarity on a printed-wiring board may be less than specified in Table 4.

Exception No. 2: Spacings between uninsulated live parts of opposite polarity on a printed-wiring board may be less than specified in Table 4, when the printed-wiring board complies with the clearances and creepage requirements specified in UL 840 for overvoltage category 3 and:

- a) for pollution degree 1 for conformal coated printed-wiring boards; or*
- b) for pollution degree 2 for uncoated printed-wiring boards.*

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4.3.2 A minimum spacing of 3.2 mm (1/8 inch) through-air shall be maintained between uninsulated live parts and a metallic flush cover plate.

4.3.3 An insulating liner or barrier used in place of required spacings may be used if it complies with Clauses 4.1.1 and 4.1.2. Electrical grade paper not less than 0.33 mm (0.013 inch) thick or mica not less than 1.65 mm (0.065 inch) thick may be used in conjunction with a through-air spacing of not less than 50 percent of the through-air spacing specified in Table 4 without additional investigation.

4.4 Means for mounting

4.4.1 A flush-type dimmer shall be provided with means for mounting in a flush-device box complying with UL 514A or UL 514C, and C22.2 No. 18, or means for mounting on a cover plate for flush-mounted wiring devices complying with UL 514D and C22.2 No. 42.1.

4.4.2 A screw provided for use in mounting a dimmer to an outlet box shall not project more than 22 mm (7/8 inch) beyond the strap or cover, and shall have a flat or blunt end. The end of the screw shall not have burrs, fins, or sharp edges that may damage insulation on wiring.

Exception: Thread-cleaning slots or grooves at the end of a screw may be used.

4.5 Current-carrying parts

4.5.1 General

4.5.1.1 A dimmer shall be provided with the means for the connection of conductors that have an ampacity at least equal to the maximum current rating of the dimmer.

4.5.1.2 The means for connection of conductors in the field shall be one of the following:

- a) a wire-binding screw with a means to retain the conductor under the screw head;
- b) pressure wire connectors that comply with UL 486A, UL 486B, or UL 486E, and C22.2 No. 65;
- c) wire leads as described in Clause 4.5.4; or
- d) an equivalent means.

4.5.2 Live parts

4.5.2.1 Uninsulated live parts shall be so secured in place by means other than friction between surfaces that displacement would not adversely affect performance, and that there is no likelihood of a reduction in spacings to values less than the minimum spacings specified in Spacings, Clause 4.3.

4.5.2.2 An uninsulated live part mounted on insulating material shall be recessed in the insulating material so that wiring cannot touch the live part.

Exception: A wiring terminal need not be so recessed.

4.5.2.3 A back wiring terminal, used on a dimmer intended for installation in a flush-device box, shall be provided with a guarding means that provides the minimum spacing specified in Table 4 between the terminal and the enclosure or wiring, other than the wiring intended for connection to the terminal.

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4.5.3 Wiring terminals

4.5.3.1 A terminal plate for a soldering lug or pressure wire connector shall be of metal not less than 1.27 mm (0.050 inch) thick, and a tapped hole for a terminal screw shall not have less than two full threads in the metal.

4.5.3.2 A terminal plate for a wire-binding screw shall be of metal not less than 0.76 mm (0.030 inch) thick, and a tapped hole shall not have less than two full threads in the metal.

Exception: A tapped hole for a screw having 32 threads per inch may have less than 2 full threads if the metal is not less than 1.52 mm (0.060 inch) thick without thread extrusions.

4.5.3.3 The terminal plate may be extruded at the tapped hole for the wire-binding screw to provide two full threads, if the thickness of the metal before extrusion is not less than the pitch of the screw thread.

4.5.3.4 A wire-binding terminal screw shall comply with the requirements for the torque and pull-out tests, Clause 5.9.

Exception: A size 8-32 or 10-32 wire-binding terminal screw need not be tested.

4.5.3.5 Unplated iron or steel shall not be used for wire-binding nuts and screws. Stainless steel, or steel that is protected against corrosion by zinc plating or an equivalent coating may be used, if the steel parts are not depended upon to carry current.

4.5.4 Supply wiring leads

4.5.4.1 Supply wiring leads shall have insulation of a type rated for the purpose, and shall not be less than 100 mm (4 inches) long. The ampacity and voltage ratings of the leads shall not be less than the maximum ratings of the dimmer, and shall be sized in accordance with Table 5.

4.5.4.2 Splicing wire connectors, if included in the package of an individually packaged dimmer, shall:

- a) comply with UL 486C and C22.2 No. 65;
- b) be rated for the size and the number of wires to be connected; and
- c) be marked in accordance with Clause 7.2.4.

4.5.5 Identification of terminals and leads

4.5.5.1 A terminal or lead intended for connection to the grounded (neutral) supply conductor shall be identified in accordance with Table 6 or Table 7.

4.6 Grounding and bonding

4.6.1 A dimmer shall be provided with one of the following means for connection to an equipment grounding lead:

- a) a grounding lead that is bare or that is a green insulated wire with or without one or more yellow stripes; or
- b) a grounding terminal identified as specified in Table 6.

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4.6.2 The length of a grounding lead shall not be less than 150 mm (6 inches), and shall be sized in accordance with Table 5. If a bonding conductor (lead or otherwise) is used to connect the yoke to the equipment grounding means, the bonding means shall be sized in accordance with Table 5.

Exception: A grounding lead or the current-carrying capacity of a bonding conductor may be smaller than specified in Table 5, if it complies with the grounding and bonding conductor test, Clause 5.14. A grounding conductor shall not be smaller than No. 18 AWG (0.82 mm²).

4.6.3 A grounding terminal shall be capable of retaining a No. 12 AWG (3.3 mm²) conductor.

4.6.4 A flush-type dimmer intended for mounting in a flush-device box shall be so constructed that a metallic flush cover plate will be bonded to ground when installed in the intended manner.

4.7 Switches

4.7.1 A dimmer shall have an air-gap switch that opens the load circuit. If the dimmer provides connection for both the grounded and ungrounded load circuit conductors, the air-gap switch shall be connected in series with the ungrounded conductor. In a multi-unit dimming system, only one unit need be provided with an air-gap switch.

4.7.1A A dimmer that is marked "OFF" shall completely disconnect all ungrounded conductors in the load circuit when in the "OFF" (open) position.

4.7.1B A dimmer shall not be marked "OFF" that incorporates an in-line component or circuit, such as a neon indicator in parallel with the air-gap switch, that passes current through the load when the air-gap switch is in the open position.

4.7.2 The actuating means of an air-gap switch that opens the load shall:

- a) be readily available to the user; and
- b) not depend on the use of tools or removal of the flush-device cover plate for operation after the dimmer is mounted as intended.

4.7.3 In a multi-unit dimming system, the unit or units that open the load circuit shall be distinguishable from units that do not open the load circuit. A unit that does not open the load circuit shall not be identifiable as being capable of opening the load circuit.

4.7.4 The switching contact in the air-gap switching mechanism of a dimmer shall not be constructed of material that is likely to corrode in service and affect the switch performance.

4.8 Flush-device cover plates

4.8.1 A flush-device cover plate provided with a dimmer shall comply with UL 514D and C22.2 No. 42.

Exception: A flush-device cover plate that is intended for decorative purposes only, need not comply if the metal yoke complies with the applicable requirements identified in UL 514D and C22.2 No. 42.1-00, Standard for Cover Plates for Flush-Mounted Wiring.

4.9 Touch dimmers

4.9.1 If an external, nonisolated sensing circuit is provided or the yoke or cover plate is conductively connected to live parts of the supply circuit for touch operation, the energy available shall be limited through the use of impedance to a leakage current not more than 0.5 mA as determined in accordance with the leakage current test for touch dimmers, Clause 5.13.

4.9.2 The impedance prescribed in Clause 4.9.1 shall be provided by two independent means. Each independent means shall be capable of limiting the available leakage current to not more than 0.5 mA.

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4.9.3 With respect to Clause 4.9.2, the following components may be used for the application:

- a) metal film, carbon film, wire wound, and metal glazed resistors;
- b) metalized polyester film capacitors;
- c) antenna-coupling and line-by-pass capacitors that comply with UL 1414; and
- d) other components investigated for the application.

5 Tests

5.1 Test conditions

5.1.1 General

5.1.1.1 Mechanical parts shall not be adjusted, lubricated, or otherwise conditioned either before or during any test. This requirement does not apply to a manufacturer's regular practice of lubricating dimmers during assembly.

5.1.1.2 The loads for the overload test, Clause 5.3, endurance test, Clause 5.4 and temperature test, Clause 6.5, are to be set before the dimmer is connected in the circuit.

5.1.1.3 The closed circuit voltage is to be 100 to 110 percent of the test voltage specified in Table 9.

5.1.1.4 A dimmer intended to be supplied from a Class 2 source and marked Class 2 need not be subjected to any of the tests specified in this Standard.

5.1.2 Overload and endurance test fuse

5.1.2.1 During the overload and endurance tests, all grounded and dead metal parts of a dimmer that are exposed to user contact, including the intended mounting surface, are to be connected through the 15-ampere fuse specified in Clause 5.1.2.2 to earth ground for a grounded neutral circuit. For any other system, the grounded and dead metal parts are to be connected through such a fuse to the live pole least likely to arc to ground.

5.1.2.2 The fuse shall be a nonrenewable, non-time delay, cartridge fuse rated for branch circuit overcurrent protection. The voltage rating of the fuse is to be equal to or greater than the maximum potential from the dimmer to the point at which dead metal parts and the intended mounting surface are connected.

5.2 Test loads

5.2.1 Tungsten-filament

5.2.1.1 If tungsten-filament lamps are used as the test load, the test load is to be the smallest possible number of lamps having standard ratings. When the load is above 500 watts the largest possible number of 500 watt lamps are to be used. With the concurrence of those concerned, a tungsten-filament lamp larger than 500 watts may be used. The maximum cycling rate for the lamp load shall not exceed 1 cycle per minute. The operating cycle is to be such that the lamps are off for at least 55 seconds of each test cycle. If a dimmer is to be operated at a rate of more than one cycle per minute, a separate lamp load of the same rating is necessary for each additional cycle per minute.

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5.2.1.2 The circuit is to reach the peak value of the inrush current in 1/240 of a second after the circuit is closed.

5.2.1.3 A synthetic load may be used in place of tungsten-filament lamps if it is equivalent to a tungsten-filament-lamp load on the test circuit. The inrush current is to be as specified in Table 8.

5.2.1.4 A synthetic load used in place of tungsten-filament lamps may consist of noninductive resistors if they are connected and controlled so that a portion of the resistance is shunted during the closing of the dimmer under test. A synthetic load may also consist of a noninductive resistor or resistors that are connected in parallel with a capacitor.

5.2.2 Magnetic ballast or transformer

5.2.2.1 The reactive components of an inductive load for testing a dimmer for either an ampere or volt-ampere alternating-current rating are not to be in parallel with other reactances or resistances. Parallel individual loads, composed of resistance and inductive-reactance components connected in series, may be used if the power factors of the parallel loads are equivalent one to the other.

Exception: An air-core reactor in any phase may be shunted by resistance in which the power loss is approximately 1 percent of the total power consumption in that phase.

5.2.2.2 The load is to be calibrated for a 75 to 80 percent power factor.

5.2.2.3 The specific magnetic ballast or transformer is to be used as the load when the dimmer is marked in accordance with Clause 7.1.5. The overload, endurance, and temperature test sequence is to be completed with the specific load.

5.2.2.4 A synthetic load may be used in place of the specific magnetic ballast or transformer if it simulates the turn-on transient and steady-state conditions of the specific magnetic ballast or transformer.

5.2.3 Electronic ballasts

5.2.3.1 A dimmer intended for use with an electronic ballast shall be marked in accordance with Clause 7.1.6.

5.2.3.1A The specific electronic ballast shall be used as the load. The overload, endurance, and temperature test sequence shall be completed with the specific load.

5.2.3.2 A synthetic load may be used in place of the specific electronic ballast if it simulates the turn-on transient and steady-state conditions of the specific electronic ballast.

5.2.4 Electronic transformer for low voltage incandescent lighting

5.2.4.1 Dimmers intended for the control of electronic low voltage incandescent lighting shall be tested using a tungsten filament lamp load unless tested in accordance with Clause 5.2.4.2 or 5.2.4.3.

5.2.4.2 The specific electronic transformer shall be used as the load when the dimmer is marked in accordance with 7.1.5. The overload, endurance, and temperature test sequence shall be completed with the specific load.

5.2.4.3 A synthetic load may be used in place of the specific electronic transformer if it simulates the turn-on transient and steady-state conditions of the specific electronic transformer.

5.3 Overload tests

5.3.1 General

5.3.1.1 At the conclusion of the overload test, a dimmer shall be capable of performing its intended function. The fuse specified in Clause 5.1.2.1 shall not open.

Exception: In a multi-unit dimming system, units not employing an air-gap switch or solid-state switch in series with the load need not be subjected to the overload test.

5.3.1.2 A dimmer is to be operated by a means that will enable its actuating member to control the load designated in test loads, Clause 5.2, for 100 cycles of operation. The cycling rate is to be 6 – 10 cycles/minute.

Exception: For a dimmer with a maximum cycling rate of less than 6 cycles/minute, the test is to be conducted at the dimmer's maximum cycling rate.

5.3.1.3 Six samples of a dimmer in the as-received condition are to be subjected to this test.

5.3.1.4 Of the six samples of a dimmer with a three-way switch subjected to the overload test, each of three samples is to be tested with the right-hand contacts making and breaking the required test load. Each of the other three samples is to be tested with the left-hand contacts making and breaking the required test load.

5.3.2 Tungsten-filament loads

5.3.2.1 For a dimmer rated 1200 watts or less, the test wattage is to be 150 percent of the rated wattage for the dimmer. For a dimmer rated greater than 1200 watts, the test wattage is to be 125 percent of the dimmer rating.

5.3.3 Magnetic or electronic ballast and transformer loads

5.3.3.1 A dimmer rated for control of an electronic or magnetic ballast load or a transformer load is to be subjected to the overload test connected to a test current of 150 percent of the dimmer's rating.

5.3.4 Type I dimmers

5.3.4.1 A Type I dimmer is to be tested while cycling the air-gap switch between the off position and the on position with the actuating member at the maximum brilliance setting.

5.3.5 Types II and IIa dimmers

5.3.5.1 A Type II or IIa dimmer is to be tested while cycling the actuating member from the off position through the full range of control and back to the off position.

5.3.6 Type III dimmers

5.3.6.1 A Type III dimmer is to be tested using the sequence (or sequences) that results in the most severe effect on the air-gap switch contacts.

5.3.7 Type IV dimmers

5.3.7.1 With the air-gap switch contacts closed, a Type IV dimmer is to be tested while cycling the actuating member through all settings that result in the minimum and maximum current through the dimmer.

5.4 Endurance test

5.4.1 General

5.4.1.1 The six samples previously subjected to the overload test are to be operated mechanically by means that will enable the actuating member to control 100 percent of the rated load for 10,000 cycles of operation. There shall be no electrical or mechanical malfunction of the dimmer. At the conclusion of the test the dimmer shall be capable of performing its intended function. The fuse specified in Clause 6.1.2.1 shall not open.

Exception: In a multi-unit dimming system, units not employing an air-gap switch or solid-state switch in series with the load need not be subjected to the endurance test.

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5.4.1.2 The cycling rate is to be 6 – 10 cycles/minute. See Clause 5.2.1.1.

Exception: For a dimmer with a maximum cycling rate of less than 6 cycles/minute, the test is to be conducted at the dimmer's maximum cycling rate.

5.4.1.3 Of the six samples of a dimmer with a three-way switch subjected to the endurance test, each of three samples is to be tested with the right-hand contacts making and breaking the required test load. Each of the other three samples is to be tested with the left-hand contacts making and breaking the required test load.

5.4.2 Types I, II, IIa, and III dimmers

5.4.2.1 A dimmer is to be operated as described in Clauses 5.3.4 – 5.3.6 for the type of dimmer.

5.5 Temperature test

5.5.1 The six dimmer samples that have completed the overload and endurance tests are to be subjected to a temperature test. Temperatures measured during the test shall not exceed the temperature limits specified in Table 10.

Exception: In a multi-unit dimming system, only one sample in the as-received condition of a unit without an air-gap switch or solid-state switch in series with the load need be subjected to the temperature test.

5.5.2 To determine if the dimmer complies with the temperature test requirements, it is to be operated under normal conditions and is to carry its rated load continuously at the test voltage specified in Table 9 until temperatures are constant.

5.5.3 A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5-minute intervals, indicate no change.

5.5.4 One sample is to be mounted in a single-unit configuration, two samples are to be mounted in a double-unit ganged configuration, and 3 samples are to be mounted in a triple-unit ganged configuration. The dimmers are to be electrically connected as intended, and are to control a load of wattage, volt-ampere, or ampere and voltage in accordance with Table 11 and the derating factor provided by the manufacturer. Temperature test set-ups as illustrated in Figure 4 are to be constructed with a single-, a double-, and a triple-unit box, as appropriate. The set-up can be modified to use the minimum number of outlet boxes needed to install the dimmer or dimmers in each configuration. A dimmer not provided with an integral cover plate is to be mounted with a nonmetallic flush-device cover plate or equivalent in position over the dimmer.

Exception: Six samples of a dimmer constructed for a single-unit configuration only are to be tested separately in the unit box of the type and size with which the unit is intended to be used.

5.5.5 A dimmer marked as specified in Clause 7.1.4 or 7.1.5 is to be subjected to the temperature test using the specific magnetic or electronic ballast or transformer load. The temperatures on the ballast or transformer are to be monitored during this test to verify operation within specified temperature limits.

5.5.6 The temperature limits specified in Table 10 are based on an assumed ambient temperature of 25°C (77°F). However, tests may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). If tested at other than 25°C (77°F), the maximum temperatures are to be adjusted accordingly.

5.5.7 Temperatures are to be measured by thermocouples consisting of wires not larger than No. 24 AWG (0.21 mm²) and not smaller than No. 30 AWG (0.05 mm²). When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of No. 30 AWG iron and constantan wire and a potentiometer-type instrument. Such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

Exception: A coil temperature may be determined by the change-of-resistance method. See Clause 5.5.12.

5.5.8 The thermocouples and related instruments are to be accurate and calibrated in accordance with standard laboratory practice. The thermocouple wire is to conform with the requirements for special thermocouples as listed in the table of limits of error of thermocouples in ANSI MC96.1-1982.

5.5.9 A thermocouple junction and adjacent thermocouple lead wires are to be securely held in thermal contact with the surface of the material, the temperature of which is being measured. In most cases, taping or cementing the thermocouple in place will provide adequate thermal contact, but if a metal surface is involved it may be necessary to braze or solder the thermocouple to the metal.

5.5.10 A thermocouple used for determining the temperature of a coil or winding is to be located on the outer surface of the coil or winding.

5.5.11 A dimmer is to be tested with 1.22 m (4 feet) of wire attached to each field-wiring terminal. The wire is to be of the smallest size having an ampacity of at least 125 percent of the test current for the load. Wire size is to be determined in accordance with the National Electrical Code, ANSI/NFPA 70-1993, and the Canadian Electrical Code (CEC), C22.1. The size is to be based upon wire that is rated for a temperature of 60°C (140°F).

5.5.12 When using the change-of-resistance method, the temperature of a winding is to be calculated using the formula:

$$T = \frac{R}{r} (k + t) - k$$

in which:

T is the final temperature in °C;

R is the resistance of the coil at the end of the test in ohms;

r is the resistance of the coil at the beginning of the test in ohms;

k is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum; values of the constant k for other conductors are to be determined; and

t is the temperature of the coil in °C at the time resistance r is being measured.

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5.6 Dielectric voltage-withstand test

5.6.1 Following the temperature test with the dimmers at the maximum temperature attained, the six previously tested dimmer samples shall withstand without breakdown a 50 – 60 Hz essentially sinusoidal potential applied as described in Clause 5.6.3 for 1 minute between:

- a) live parts of line-connected circuits, and grounded and dead metal parts;
- b) live parts of line-connected circuits of opposite polarity; and
- c) live parts of line-connected circuits and low-voltage circuits.

5.6.2 The test potential is to be 1500 volts, or 1000 volts plus twice the maximum rated voltage, whichever is greater.

5.6.3 The dimmer is to be tested by means of a 500 volt-ampere or larger capacity transformer whose output voltage is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test level is reached, and is to be held at that level for 1 minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

Exception: A 500 volt-ampere or larger-capacity transformer need not be used if the transformer is provided with a voltmeter that measures the applied output potential directly.

5.6.4 A component that has been investigated for line-to-ground, or across-the-line applications may be disconnected from the circuit before the test.

5.7 Air-gap switch test

5.7.1 Six as-received samples of a Type II, a Type III, or a Type IV dimmer are to be tested at rated load for 100 cycles with a short circuit across the dimming control circuitry (power semiconductor) in the dimmer so that the air-gap switch contacts control the load directly.

Exception: If a Type III dimmer switches from off to maximum brightness, then the air-gap switch contacts need not be subjected to this test.

5.7.2 As a result of the test, there shall not be electrical or mechanical breakdown of the dimmer, undue burning or pitting of the contacts, or welding of the contacts.

5.8 Security of lead test

5.8.1 The connection of each factory-installed wire lead shall withstand a tensile force gradually increased to 90 N (20 lbf) for 1 minute without visible displacement of the lead. This test is to be conducted on each lead of a dimmer sample, and may be conducted on a previously tested or untested sample.

5.9 Torque and pull-out tests

5.9.1 With reference to Clause 4.5.3.4, the terminal strength of a dimmer having wire-binding screw terminations is to be investigated in accordance with Clauses 5.9.2 and 5.9.3. There shall not be any damage to the terminals or dimmer. There shall not be any visible displacement of the wires relative to the terminals following the pull test applied as described in Clause 5.9.3.

5.9.2 Each terminal is to be wired with No. 12 AWG (3.3 mm²) solid copper conductor by applying a tightening torque of 1.8 N·m (16 lbf-in.) to the terminal screw. The conductor is to be placed under the screw head and wrapped 2/3 – 3/4 turn around the screw. The screw is to be tightened with a clutch-type torque screwdriver which has been calibrated and preset to release at the specified value. Each termination is then to be disassembled and the test repeated once using newly stripped wire.

5.9.3 Following the torquing, each terminal is to be subjected to a tensile force gradually increased to 90 N (20 lbf) applied to each wire for 1 minute.

5.10 Limited short-circuit test

5.10.1 Six samples of a dimmer in the as-received condition are to be tested in series with a 30-ampere nonrenewable, non-time delay, cartridge fuse rated for branch circuit overcurrent protection on an alternating-current circuit of rated voltage capable of delivering 1000 amperes peak when the system is short-circuited at the testing terminals. A load with a 0.98 – 1.00 power factor is to be used to limit the current. There shall be no ignition of the cotton, the 15-ampere fuse specified in Clause 5.10.2 shall not open, and the terminals or leads of the dimmer shall not be visibly damaged. The dimmer need not be operable after the test.

Exception: In a multi-unit dimming system, units not employing an air-gap switch or solid-state switch in series with the load need not be subjected to the limited short-circuit test.

5.10.2 Each sample is to be installed in a metal flush-device box mounted in the test fixture illustrated in Figure 3, and covered with a metal flush-device cover plate, unless a noninterchangeable cover is provided with the dimmer. The enclosure and any other exposed dead metal are to be connected to ground through a 15-ampere nonrenewable, non-time delay, cartridge fuse rated for branch circuit overcurrent protection. Cotton is to be draped over the entire exposed surface of the dimmer after installation in the test fixture. The short circuit is to connect the dimmer output to the opposite polarity conductor of the supply circuit.

5.10.3 The first set of three samples is to have the air-gap switch in the closed position and the short-circuit open at the start of the test. The test is to be conducted by closing the short-circuit on the air-gap switch. The second set of three samples is to have the air-gap switch in the open position and the short circuit closed at the start of the test. The test is to be conducted by closing the air-gap switch on the short-circuit.

5.10.4 For the first set of three samples specified in Clause 5.10.3, the dimmers are to be adjusted as follows:

- a) at the maximum brilliance setting on the first sample;
- b) at the minimum brilliance setting on the second sample; and
- c) at a setting midway between minimum and maximum brilliance on the third sample.

5.10.5 For Types I, II, III, and IV dimmers, the second set of three samples specified in Clause 5.10.3 is to be adjusted as for the first set of samples described in Clause 5.10.4. For Type IIa dimmers, the second set of 3 samples is to be adjusted at the maximum brilliance setting.

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5.11 D-C offset test

5.11.1 A dimmer intended to control a magnetic ballast or a transformer shall not have a d-c component greater than 2 volts when subjected to the d-c offset test as described in Clauses 5.11.2 – 5.11.4. A single previously untested dimmer may be used for this test.

5.11.2 The dimmer is to be operated at rated load until temperatures are constant as specified in Clause 5.5.3.

5.11.3 A d-c voltmeter with a damped frequency response in the 0 to 120 hertz range is to be used to measure the d-c voltage across the test load.

5.11.4 The test is to include varying the actuating member through its entire operating range.

5.12 Mold stress-relief distortion test

5.12.1 Conditioning as described in Clause 5.12.2 of a dimmer that has a thermoplastic part shall not cause softening of the material as determined by handling immediately after the conditioning, nor shall there be shrinkage, warpage, or other distortion after cooling to room temperature, that results in any of the following:

- a) reduction of spacings between uninsulated live parts of opposite polarity, uninsulated live parts and accessible dead or grounded metal, or uninsulated live parts and the enclosure below the values specified Table 4;
- b) making uninsulated live parts or internal wiring accessible to contact, or defeating the integrity of the enclosure so that mechanical protection is not afforded to internal parts of the dimmer; or
- c) causing interference with the intended operation or servicing of the dimmer.

5.12.2 One complete dimmer (in the case of an enclosure) or the part under consideration, is to be placed in a full-draft circulating-air-oven maintained at a uniform temperature at least 10°C (18°F) higher than the maximum temperature of the material measured under normal operating conditions, but not less than 70°C (158°F). The sample is to remain in the oven for 7 hours.

5.13 Leakage current test for touch dimmers

5.13.1 The leakage current of a touch dimmer shall not exceed 0.5 mA when tested in accordance with the Clauses 5.13.2 – 5.13.7. A touch dimmer in the as-received condition is to be subjected to this test.

5.13.2 The test circuit is to be as shown in Figure 3.

5.13.3 The meter may be electronic or a direct-indicating type, and is to:

- a) indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor;
- b) be calibrated at 60 Hz;
- c) indicate the rms value of a pure sine wave with an accuracy of 5 percent at an indication of 0.5 mA; and
- d) have a terminal impedance of 1500 ohms shunted by a 0.15 microfarad capacitor.

5.13.4 The test frequency is to be 60 hertz, and the test voltage is to be as specified in Table 9.

5.13.5 At the start of the test, the touch dimmer is to be at room temperature with all dimmer switches in the closed position and the S1 switch open. See Figure 3. The leakage current is to be measured within 5 seconds of closing the S1 switch, and again after 1 hour of continuous operation. The leakage current is to be measured at the low, medium, and high settings of the touch dimmer.

5.13.6 The leakage current is to be measured with the S2 switch in position A, with the S2 switch in position B, and with the S1 switch both closed and open. See Figure 3.

5.13.7 The probe is to be applied to the surface of the dimmer intended for touch actuation of the dimmer.

5.14 Grounding and bonding conductor test

5.14.1 With respect to the Exception to 4.6.2, a dimmer is to be subjected to both of the tests specified in (a) and (b). The grounding lead or bonding conductor (lead or otherwise) shall not open:

- a) when carrying 40 amperes for 2 minutes on one sample; and
- b) when subjected to the test on three separate samples specified in Clause 5.14.2.

5.14.2 Three dimmer samples in the as-received condition are to be tested in series with a 20-ampere nonrenewable, non-time delay, cartridge fuse rated for branch circuit overcurrent protection on an a-c circuit at rated voltage capable of delivering 1000 amperes peak when the system is short-circuited at the testing terminals. A load with a 0.98 – 1.00 power factor is to be used to limit the current. One test is to be performed on the grounding lead, bonding conductor, or both the grounding lead and the bonding conductor of each dimmer sample.

6 Manufacturing and production tests

6.1 Dielectric voltage-withstand test

6.1.1 Each dimmer shall withstand without electrical breakdown, as a routine production-line test, the application of a 40 – 70 hertz potential between live parts and accessible dead metal parts that are likely to become energized.

6.1.2 The production-line test shall be in accordance with either condition A or condition B of Table 12.

6.1.3 The dimmer may be in a heated or unheated condition for the test.

6.1.4 The test is to be conducted when the dimmer is completely assembled. It is not intended that the dimmer be unwired, modified, or disassembled for the test.

Exception No. 1: Parts such as snap covers or friction-fit knobs that would interfere with performing the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed dimmer.

6.1.5 The test equipment shall include a transformer having an essentially sinusoidal adequate output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic feature to reject any unacceptable unit.

6.1.6 If the output of the test equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

6.1.7 If the transformer output is 500 volt-amperes or larger, the test potential may be indicated:

- a) by a voltmeter in the primary circuit or in a tertiary-winding circuit;
- b) by a selector switch marked to indicate the test potential; or
- c) by a marking in a readily visible location to indicate the test potential of equipment having a single test potential output. If marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

6.1.8 Test equipment other than those described in Clauses 6.1.5 – 6.1.7 may be used if found to accomplish the intended factory control.

6.1.9 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the dimmer are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to accessible dead metal.

7 Markings

Advisory Note: *In Canada, there are two official languages, therefore, it is necessary to have CAUTION markings in both English and French. Appendix B lists acceptable French translations of the markings specified in this Standard. When a product is not intended for use in Canada, cautionary markings may be provided in English only.*

7.1 General

7.1.1 A dimmer shall be permanently marked with the maximum electrical ratings, including volts, amperes or watts, and hertz, where visible after installation without a removable flush-device cover plate in place. The marking may be on the subplate or mounting yoke. The marking shall not be on removable plaster ears. The marking of a dimmer that has an integral flush cover plate of insulating material may be on the inside of the cover plate.

7.1.2 In addition to the marking specified in Clause 7.1.1, a dimmer shall be permanently marked on a part that is not readily removable with:

- a) the manufacturer's name or trademark or other descriptive marking by which the organization responsible for the product can be identified;
- b) the statement, "For Control Of Permanently Installed _____ Lamp Fixtures Only" or the equivalent. The blank is to be filled in with the appropriate type of lighting load (that is incandescent, fluorescent, or low voltage); and

c) the date or other dating period of manufacture not exceeding any three consecutive months.

Exception: The date of manufacture may be abbreviated in a nationally accepted conventional code, or in a code affirmed by the manufacturer, if the code:

a) does not repeat in less than 20 years; and

b) does not require reference to the manufacturer's records to determine when the dimmer was manufactured.

7.1.2A If a manufacturer produces dimmers at more than one factory, each dimmer shall have a distinctive marking, which may be in code, by which it may be identified as the product of a particular factory.

7.1.3 A dimmer shall be marked with the model number, catalog number or similar identification on the dimmer or on the smallest unit container, or on information sheet in the smallest unit container.

7.1.4 The derating factor (see Clause 5.5.4) for a multi-unit ganged installation, in increments of 50 watts or 50 volt-amperes, shall be provided on the dimmer, on the packaging or on the instruction sheet packaged with the dimmer.

7.1.5 With reference to Clause 5.2.2.3, a marking shall be provided on the dimmer, package, or an instruction sheet specifying the manufacturer's name and model number or numbers of the magnetic ballast or transformer with which the dimmer is intended to be used.

7.1.6 With reference to Clause 5.2.3.1, a dimmer, intended for control of an electronic ballast load, shall be marked with the manufacturer's name and model number of the electronic ballast or ballasts with which the dimmer is intended to be used. The marking shall be on the dimmer or provided with the dimmer on the packaging or stuffer sheet.

7.1.7 Markings required to be permanent shall be molded, die-stamped, paint-stencilled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive that, upon investigation, is found to be acceptable for the application. Ordinary usage, handling, storage, and the like are to be considered in the determination of the permanence of a marking.

7.1.8 A required marking shall be located on the dimmer, on a separate instruction sheet, or on the smallest unit packaging, unless otherwise specified.

7.1.9 A dimmer intended to be supplied from a Class 2 source shall be marked Class 2.

7.2 Field wiring terminals

7.2.1 A dimmer employing wiring terminals rated for copper wire only shall be permanently marked with one of the following or the equivalent:

- a) "Use copper wire only;"
- b) "Cu wire only;" or
- c) a marking containing both the symbols illustrated in Figure 5(a).

7.2.2 A dimmer employing wiring terminals rated for aluminum wire only shall be permanently marked with one of the following or the equivalent:

- a) "Use aluminum wire only;" or
- b) "Al wire only."

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7.2.3 A dimmer employing wiring terminals rated for both copper and aluminum wire shall be permanently marked with one of the following or the equivalent:

- a) "Use copper or aluminum wire;"
- b) "Cu or Al wire;" or
- c) a marking containing both the symbols illustrated in Figure 5(b).

7.2.4 If a splicing wire connector is provided with an individually packaged dimmer as mentioned in Clause 4.5.4.2, the dimmer shall be provided with instructions for the intended use of the splicing wire connector. The instructions shall be provided on the dimmer, on the package, or on a separate instruction sheet to be included in the package. The instructions shall include:

- a) the insulation strip length;
- b) the wire sizes, combinations of wire sizes, and number of wires intended to be connected; and
- c) if the dimmer is rated for use with:
 - 1) copper wire only, one of the statements specified in Clause 7.2.1;
 - 2) aluminum wire only, one of the statements specified in Clause 7.2.2; or
 - 3) both aluminum and copper wire, one of the statements specified in Clause 7.2.3.

7.2.5 With reference to footnote b of Table 10, a dimmer may be marked at the point of connection to field wiring with the following or equivalent statement: "For supply connection, use wires rated for at least 75°C."

7.3 Cautionary

7.3.1 One of the following cautionary markings shall be located on the dimmer, on a separate instruction sheet packaged with the dimmer, or on the smallest unit packaging. The marking shall consist of the signal word "CAUTION", and one of the statements in (a), (b), or (c) or the equivalent:

- a) for dimmers controlling a ballast – "To Reduce the Risk of Overheating And Possible Damage To Other Equipment, Do Not Install To Control A Receptacle, A Motor-Operated Appliance, Or A Transformer-Supplied Appliance;"
- b) for dimmers controlling a tungsten-filament – "To Reduce the Risk of Overheating And Possible Damage To Other Equipment, Do Not Install To Control A Receptacle, A Motor-Operated Appliance, A Fluorescent Lighting Fixture, Or A Transformer-Supplied Appliance;" or
- c) for dimmers controlling a low-voltage transformer – "To Reduce the Risk of Overheating And Possible Damage To Other Equipment, Do Not Install To Control A Receptacle Or A Motor-Operated Appliance."

7.3.2 The signal word "CAUTION" shall be more prominent than any other required marking on the dimmer.

Table 1 – Maximum performance level category (PLC) for polymeric material used as electrical insulation

(See Clause 4.1.2)

Test specified	Flammability rating of material ^a			
	5VA, 5VB	V-0	V-1	V-2
Comparative Tracking Index (CTI)	3 ^b	3 ^b	3 ^b	3 ^b
High-Current Arc Resistance to Ignition (HAI)	2	3	2	2
Hot-Wire Ignition (HWI)	3	4	3	2

^a A polymeric material subjected to the flammability test with either the 12 mm or 3/4 inch flame in accordance with Exception No. 1 to 4.1.1 shall comply with the PLC for a V-1 rating.

^b A material having a comparative tracking index PLC of 4 may be used if the voltage involved is 250 volts or less.

Table 2 – Maximum performance level category (PLC) for polymeric material used as an enclosure part

(See Clause 4.1.2)

Test specified	Flammability rating of material ^a			
	5VA, 5VB	V-0	V-1	V-2
High-Current Arc Resistance to Ignition (HAI)	2	3	2	2

^a A polymeric material that complies with Exception No. 1 to 4.1.1 shall comply with the PLC for a V-1 rating.

Table 3 – Minimum relative thermal index rating for polymeric materials used as electrical insulation or as an enclosure part

(See Clause 4.1.3)

Application	RTI criteria	Minimum rating, °C
Electrical insulation or enclosure part	Electrical	80
	Mechanical with impact	60
	Mechanical without impact	80

Note – Relative thermal index (RTI) is specified in UL 746B.

Table 4 – Minimum spacings

(See Clauses 4.1.1, 4.1.2, 4.3.1, 4.5.2.3)

Rating, volts ac	Through air and over surface spacings	
	mm	(inches)
0 – 300	1.2	(3/64)
301 – 600	3.2	(1/8)

Table 5 – Minimum size of leads**(See Clauses 4.5.4.1, 4.6.2, 5.14.2)**

Dimmer rating, amperes	Copper supply leads,		Copper grounding leads,	
	AWG	(mm ²)	AWG	(mm ²)
0 – 6	18	(0.82)	18	(0.82)
6.1 – 10	16	(1.3)	16	(1.3)
10.1 – 15	14	(2.1)	14	(2.1)
15.1 – 20	12	(3.3)	12	(3.3)

Table 6 – identification of wiring terminals**(See Clauses 4.5.5.1, 4.6.1)**

Identification by:	Grounded (neutral) terminal	Equipment grounding terminal	All other terminals
Wire-binding screw	White metal or plating on circular screw head	Hexagonal, green-colored nut ^b or slotted screw head ^b	Other than white or green circular screw head
Visible pressure wire connector	White metal or plating on connector	Green-colored connector, screw or appendage ^b	Other than white or green colored connector
Concealed pressure wire connector	Distinct white-colored area adjacent to wire entrance hole or the word "white" or "neutral" distinctively marked adjacent to wire entrance hole	Distinct green-colored area adjacent to wire entrance hole or the word "green" ^c distinctively marked adjacent to wire entrance hole	Other than white or green area adjacent to wire entrance hole
Terminal plate ^a	White metal or plating	–	Other than white or green metal or plating
Insulating enclosure or terminal	The word "White" or "Neutral" marked on or directly adjacent to terminal or White metal or plating on terminal	The word "Green" ^d marked on or directly adjacent to terminal or Green colored terminal	– Other than white or green-colored terminal

^a Only if all line-terminal binding screws are of the same color.

^b Not readily removable.

^c In letters at least 1/16 inch (1.6 mm) high. The word "ground", the letters "GR", or the grounding symbol in Figure 1 may be used.

^d The word "Ground", the letters "GR", or the grounding symbol in Figure 1 may be used.

Table 7 – Identification of leads**(See Clause 4.5.5.1)**

Identification obtained by	Grounded (neutral) lead	Grounding lead
Color of braid	Solid white or natural gray (without tracer)	Green (without tracer)
	White or natural gray with colored tracer in braid to identify the manufacturer	Green (without tracer)
Color of insulation	Solid white or natural gray; white or natural gray, on contrasting color other than green	Green

Table 8 – Tungsten-filament lamp load test circuit characteristics**(See Clause 5.2.1.3)**

Steady-state current (rms), amperes	Minimum inrush current (peak), amperes
5	78
10	141
15	191
20	226

Table 9 – Test voltages**(See Clauses 5.5.2, 5.13.4, 5.14.2)**

Dimmer rating, a-c volts	Test voltage
110 – 120	120
220 – 240	240
254 – 277	277
347	347
440 – 480	480
550 – 600	600
All other ratings	Rated voltage

Table 10 – Maximum temperature limits**(See Clauses 7.2.3, 5.5.1, 5.5.6)**

Materials and components	°C	°F
1. Fuses	90	194
2. Fiber employed as electrical insulation	90	194
3. Wood and other combustible material	90	194
4. Surfaces likely to contact the insulation of field wiring ^{a,b}	75	167
5. A surface upon which a permanently wired unit might be mounted in service and surfaces that might be adjacent to the unit when it is so mounted, including the yoke	90	194
6. Class 105 insulation systems on windings of coils:		
Thermocouple method	90 ^c	194 ^c
Resistance method	100 ^c	212 ^c
7. Molded phenolic composition	150 ^d	302 ^d
8. Rubber or thermoplastic-insulated wires and cords	60 ^d	140 ^d
9. Surfaces accessible during normal operation ^h	60	140
10. Semiconductor junction	e	e
11. Electrolytic capacitor ^f	65	149
12. Printed-wiring boards	g	g

NOTE – See 5.5.6.

^a Any part of the dimmer or box more than 1/4 inch (6.4 mm) behind the mounting yoke shall be considered a part that can be contacted by field wiring unless specific barriers or construction features do not provide room for field wiring to access these areas.

^b Dimmers that are marked for use with 75°C (167°F) or greater field wiring shall be allowed to obtain a maximum of 90°C (194°F) where contact with field wiring is possible. See Clause 7.2.4.

^c At a point on the surface of a coil where the temperature is affected by an external source of heat, the maximum temperature measured by means of a thermocouple may be 5°C (9°F) higher than that specified, if the maximum temperature of the coil as measured by the change-of-resistance method is not more than specified.

^d The limitations on phenolic composition and on rubber and thermoplastic insulations do not apply to compounds that have been found suitable for higher temperature.

^e The maximum acceptable temperature of a semiconductor junction cannot exceed the manufacturer's rating for the semiconductor. The temperature T_J at a semiconductor junction is related to the power P_J dissipated at the junction, the thermal resistance K_{TH} from the junction to the cooling medium (generally, the specifications for the semiconductor device will include the thermal resistance), and the temperature T_M of that cooling medium, as shown:

$$T_J = T_M + (K_{TH}) P_J$$

^f A capacitor operating at a higher temperature may be accepted on the basis of its marked temperature rating.

^g Printed-wiring boards are to be used at temperatures equal to or less than their temperature rating.

^h Does not apply to a screwhead. A heat sink located behind the plane of the face plate and exposed not more than 19 mm (3/4 inch) shall not exceed 90°C.

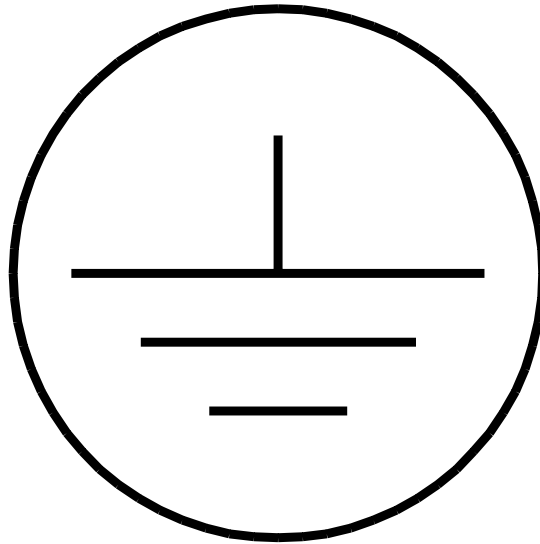
Table 11 – Temperature test conditions**(See Clause 5.5.4)**

Overload and endurance test conditioned samples	Test box condition	Load
1	single-unit	100 percent of rated load
2	double-unit	loaded in accordance with manufacturer's derating factor
3		
4	triple-unit	loaded in accordance with manufacturer's derating factor
5		
6		

Table 12 – Production-line test conditions**(See Clause 6.1.2)**

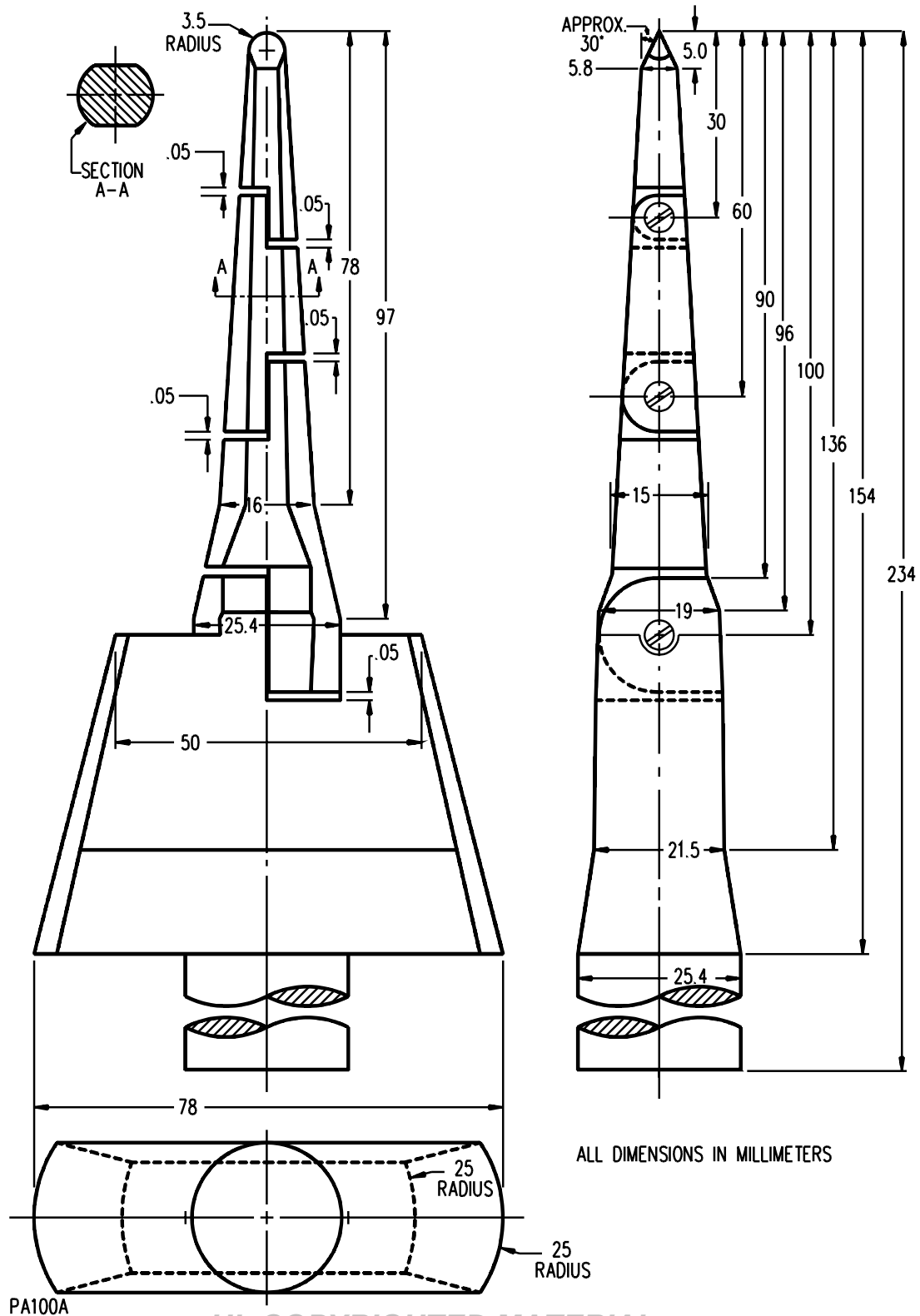
Dimmer rating	Condition A		Condition B	
	Potential, volts	Time, seconds	Potential, volts	Time, seconds
250 volts or less	1500	60	$1200 + 2.4V^{a,b}$	1
251 – 600 volts	$1000 + 2V^a$	60	$1200 + 2.4V^a$	1
^a Rated voltage of the dimmer.				
^b Shall not be less than 1500 volts.				

Figure 1 – Grounding symbol
(See Table 6, item d)



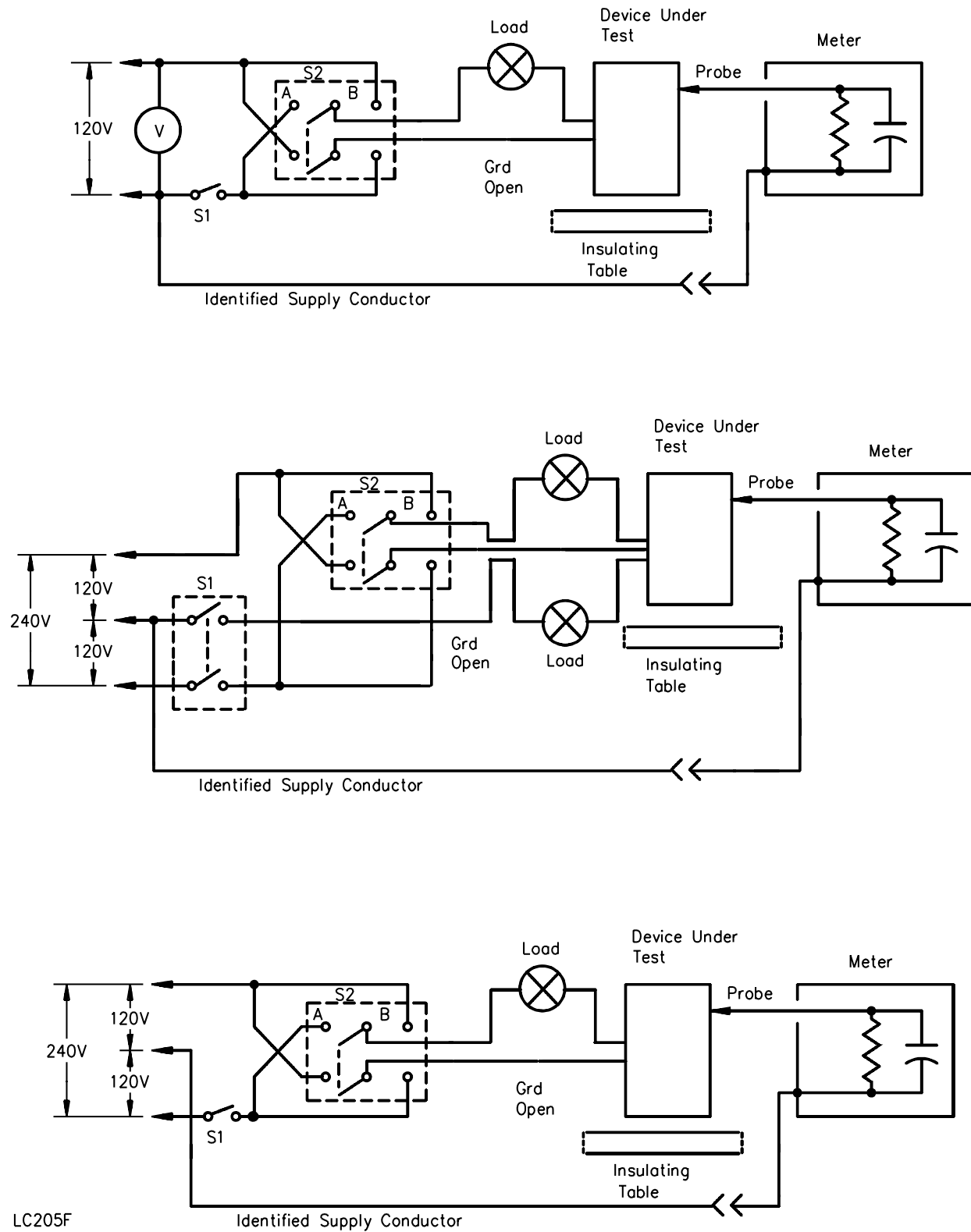
IEC417, Symbol 5019

Figure 2 – Articulate probe with web stop
(See Clause 4.8.1)



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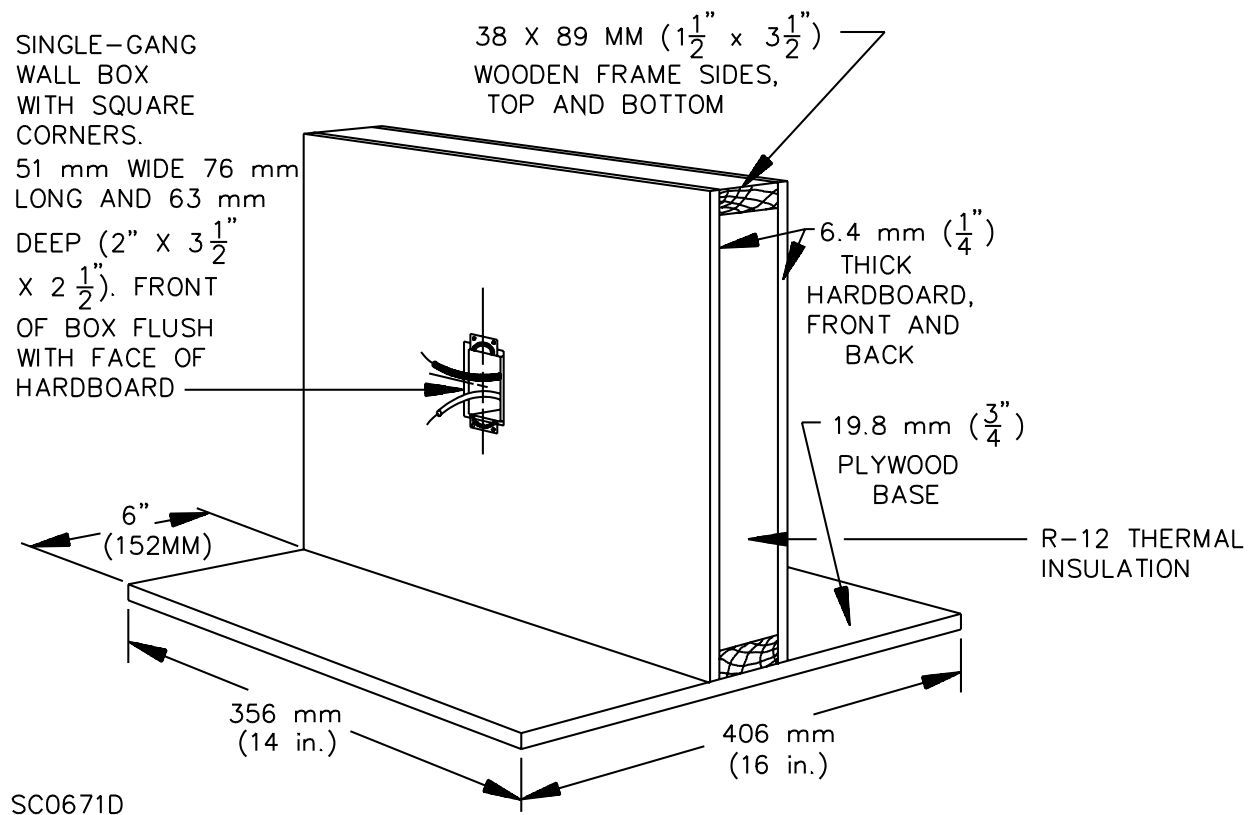
Figure 3 – Leakage current test circuits
(See Clauses 5.13.2, 5.13.6)



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Figure 4 – Temperature test setup
(See Clauses 5.5.4, 5.10.2)



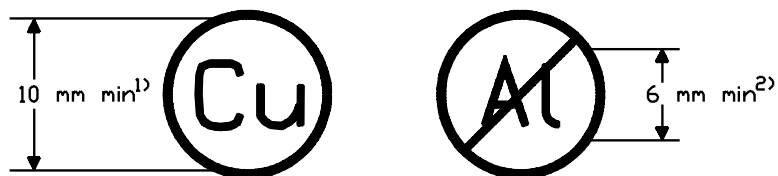
Notes –

- 1) The test set-up can be modified for the double-unit and triple-unit configurations or for a unit that requires more than one gangable box for installation in a single-, double-, or triple configuration. See 5.5.4. The box or boxes shall be centered in the test wall.
- 2) A device tested in a wall box with dimensions larger than specified shall be marked to identify the dimensions suitable for mounting. In addition the installation instructions shall provide this information. A wall box that is deeper than 63 mm (2-1/2 inches) may be used as needed.
- 3) The wallbox is to be of metal.
- 4) R12 insulation may be used in place of R11 insulation.
- 5) The test wall is to be 457 mm (18 inches) high minimum.

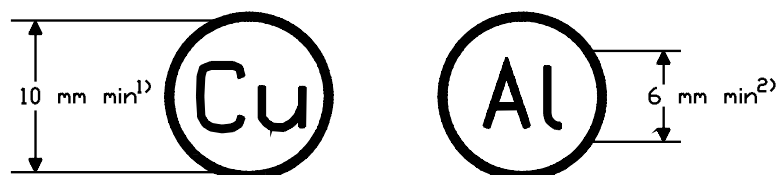
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Figure 5 – Terminal marking symbols
(See Clause 7.2.1, 7.2.3)

(a) For a terminal rated for copper wire only:



(b) For a terminal rated for use with both copper and aluminum wire:



Notes

- 1) 4 mm if marked on the dimmer.
- 2) 2.4 mm if marked on the dimmer.

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Appendix A

Standards for Components

A1 Component Standards

A1.1 The CSA and UL standards listed below are used for evaluation of components and features of products covered by this Standard. These Standards shall be considered to refer to the latest edition and all amendments published to that edition.

CSA Standards

C22.1-1994,
Canadian Electrical Code (CEC)

C22.2 No. 0.17,
Evaluation of Properties of Polymeric Materials

C22.2 No. 18-92,
Outlet Boxes, Conduit Boxes and Fittings

C22.2 No. 42-M1984,
General Use Receptacles, Plugs and Similar Wiring Devices

C22.2 No. 43-M1984,
Lampholders

C22.2 No. 55-M1986,
Special Use Switches

C22.2 No. 65-93,
Wire Connectors

C22.2 No. 111-M1986,
General Use Switches

C22.2 No. 188-M1983,
Splicing Wire and Cable Connectors

UL Standards

Attachment Plugs and Receptacles –
UL 498

Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors –
UL 486E

Flammability of Plastic Materials for Parts in Devices and Appliances –
UL 94

Industrial Control Equipment –
UL 508

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Outlet Boxes, Flush Device Boxes, and Covers, Nonmetallic –
UL 514C

Outlet Boxes, Metallic –
UL 514A

Polymeric Materials – Use in Electrical Equipment Evaluation –
UL 746C

Polymeric Materials – Long Term Property Evaluations –
UL 746B

Receptacles and Switches Intended for Use With Aluminum Wire –
UL 1567

Solid-State Controls for Appliances –
244A

Terminal Blocks –
UL 1059

Wire Connectors and Soldering Lugs for Use With Copper Conductors –
UL 486A

Wire Connectors for Use With Aluminum Conductors –
UL 486B

Wire Connectors, Splicing –
UL 486C

Wire, Flexible Cord and Fixture –
UL 62

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Appendix B

French translations and markings

Note: *This Appendix is provided for information only.*

English

7.3.2(a)

TO REDUCE THE RISK OF OVERHEATING AND POSSIBLE DAMAGE TO OTHER EQUIPMENT, DO NOT INSTALL TO CONTROL A RECEPTACLE, A MOTOR OPERATED APPLIANCE, OR A TRANSFORMER-SUPPLIED APPLIANCE

7.3.2(b)

TO REDUCE THE RISK OF OVERHEATING AND POSSIBLE DAMAGE TO OTHER EQUIPMENT, DO NOT INSTALL TO CONTROL A RECEPTACLE, A MOTOR OPERATED APPLIANCE, A FLUORESCENT LIGHTING FIXTURE, OR A TRANSFORMER-SUPPLIED APPLIANCE

7.3.2(c)

TO REDUCE THE RISK OF OVERHEATING AND POSSIBLE DAMAGE TO OTHER EQUIPMENT, DO NOT INSTALL TO CONTROL A RECEPTACLE OR A MOTOR OPERATOR APPLIANCE

French

GRADATEURS COMMANDANT UN BALLAST—AFIN DE REDUIRE LE RISQUE DE SURCHAUFFE ET LA POSSIBILITE D'ENDOMMAGEMENT A D'AUTRES MATERIELS, NE PAS INSTALLER POUR COMMANDER UNE PRISE, UN APPAREIL A MOTEUR OU UN APPAREIL ALIMENTE PAR UN TRANSFORMATEUR

GRADATEURS COMMANDANT UNE LAMPE A FILAMENT DE TUNGSTENE— AFIN DE REDUIRE LE RISQUE DE SURCHAUFFE ET LA POSSIBILITE D'ENDOMMAGEMENT A D'AUTRES MATERIELS, NE PAS INSTALLER POUR COMMANDER UNE PRISE, UN APPAREIL A MOTEUR, UNE LAMPE FLUORESCENTE OU UN APPAREIL ALIMENTE PAR UN TRANSFORMATEUR

GRADATEURS COMMANDANT UN TRANSFORMATEUR— AFIN DE REDUIRE LE RISQUE DE SURCHAUFFE ET LA POSSIBILITE D'ENDOMMAGEMENT A D'AUTRES MATERIELS, NE PAS INSTALLER POUR COMMANDER UNE PRISE OU UN APPAREIL A MOTEUR

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