

Light emitting diode (LED) equipment for lighting applications



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CAN/CSA-C22.2 No. 250.13-12

A National Standard of Canada

Light emitting diode (LED) equipment for lighting applications



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Preface

This is the first edition of CAN/CSA-C22.2 No. 250.13, *Light Emitting Diode (LED) equipment for use in lighting applications*, one of a series of Standards issued by the Canadian Standards Association under Part II of the *Canadian Electrical Code*.

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For general information on the Standards of the *Canadian Electrical Code, Part II*, see the Preface of CSA C22.2 No. 0, *General Requirements — Canadian Electrical Code, Part II*.

This Standard is considered suitable for use for conformity assessment within the stated scope of the Standard.

This Standard was prepared by the Integrated Committee on Lighting Products, under the jurisdiction of the Technical Committee on Consumer and Commercial Products and the Strategic Steering Committee on Requirements for Electrical Safety, and was formally approved by the Technical Committee. This Standard has been approved as a National Standard of Canada by the Standards Council of Canada.

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January 2012

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 - (c) wording of the proposed change; and
 - (d) rationale for the change.

CAN/CSA-C22.2 No. 250.13-12

Light emitting diode (LED) equipment for lighting applications

1 Scope

1.1

The requirements specified in this Standard cover light emitting diode (LED) equipment that is an integral part of a luminaire or other lighting equipment, and which operates in the visible light spectrum between 400 – 700 nm. These requirements also cover the component parts of LED equipment, including LED controlgear, controllers, arrays, modules, and packages, as defined in this Standard.

1.2

These lighting products are intended for installation on branch circuits of 600 V nominal or less, in accordance with the *Canadian Electrical Code, Part I*, and for connection to isolated (non-utility connected) power sources such as generators, batteries, fuel cells, solar cells, and the like.

1.3

1.3.1

LED equipment is utilized in lighting products that comply with the end-product standards listed in this Clause. The requirements specified in this Standard are intended to supplement those in other end-product standards.

1.3.2

LED luminaires comply with the following end-product standards:

- (a) CSA C22.2 No. 207;
- (b) CSA C22.2 No. 12;
- (c) CSA C22.2 No. 89;
- (d) CSA C22.2 No. 141;
- (e) CSA C22.2 No. 166;
- (f) CAN/CSA-C22.2 No. 9;
- (g) CSA C22.2 No. 250.0;
- (h) CSA C22.2 No. 256;
- (i) CSA C22.2 No. 250.7;
- (j) CSA C22.2 No. 1993;
- (k) CSA TIL B-31B; and
- (l) CSA TIL B-39.

1.3.3

LED controlgear complies with the following end-product standards:

- (a) CAN/CSA-C22.2 No. 223; and
- (b) CSA C22.2 No. 60950-1.

1.4

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1.5

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C22.1-12

Canadian Electrical Code, Part I

CAN/CSA C22.2 No. 0-10

General Requirements — Canadian Electrical Code, Part II

C22.2 No. 0.2-93 (R2008)

Insulation coordination

C22.2 No.0.8-09

Safety functions incorporating electronic technology

C22.2 No. 0.15-01(R2006)

Adhesive labels

CAN/CSA-C22.2 No. 0.17-00 (R2009)

Evaluation of properties of polymeric materials

C22.2 No. 9.0-96 (R2011)

General requirements for luminaires

C22.2 No. 12-82 (R2008)

Portable luminaires

C22.2 No. 21-95

Cord sets and power supply cords

C22.2 No. 35-09

Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable

C22.2 No. 42-10

General use receptacles, attachment plugs, and similar wiring devices

C22.2 No. 66.1-06 (2011)

Low voltage transformers — Part 1: General requirements

C22.2 No. 66.2-06 (R2011)

Low voltage transformers — Part 2: General purpose transformers

C22.2 No. 66.3-06 (R2011)

Low voltage transformers — Part 3: Class 2 and Class 3 transformers

C22.2 No. 89-76 (2008)

Swimming-pool luminaires, submersible luminaires and accessories

C22.2 No. 107.1-01 (R2011)

General use power supplies

C22.2 No. 141-10

Emergency lighting equipment

C22.2 No. 166-M1983 (R2008)

Stage and studio luminaires

C22.2 No. 207-M89 (R2008)

Portable and stationary electric signs and displays

CAN/CSA-C22.2 No. 223-M91 (R2008)

Power supplies with extra-low-voltage Class 2 outputs

CAN/CSA-C22.2 No. 248.14-00 (R2010)

Low-voltage fuses — Part 14: Supplemental fuses

C22.2 No. 250.0-08

Luminaires

C22.2 No. 250.7-07

Extra low-voltage landscape lighting systems

C22.2 No. 256-05 (R2010)

Direct plug-in night lights

C22.2 No. 1993-09

Self-ballasted lamps and lamp adapters

CAN/CSA-C22.2 No. 60065-03 (R2007)

Audio, video and similar electronic apparatus — Safety requirements

CAN/CSA-C22.2 No. 60950-1-07

Information technology equipment — Safety — Part 1: General requirements

CAN/CSA-E60384-1-03 (R2007)

Fixed capacitors for use in electronic equipment — Part 1: Generic specification

CAN/CSA-E60384-14-09

Fixed capacitors for use in electronic equipment — Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

CAN/CSA-E60691-08

Thermal-links — Requirements and application guide

TIL B-31B

Portable (temporary) luminaire lighting strings

TIL B-39

Flexible light cable systems (ropelights)

ASTM (American Society for Testing and Materials)

D1000-10

Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

E28-99 (2009)

Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus

IEC (International Electrotechnical Commission)

60417-1:2000

Graphical symbols for use on equipment

NRCC (National Research Council Canada)

National Building Code of Canada, 2010

3 Definitions

The following definitions shall apply in this Standard:

Barrier — part of a unit intended to physically limit access to parts that pose a risk of electric shock.

Circuit, Class 2 — a circuit supplied by an isolating source that complies with the requirements of CAN/CSA-C22.2 No. 223, or both CSA C22.2 No. 66.1 and CSA C22.2 No. 66.3.

Circuit, isolated low voltage limited energy (LVLE) — a circuit that exhibits no fire hazards and voltages that are safe to touch under both normal operating conditions and after a single fault condition.

Notes:

- (1) LVLE circuit complies with the requirements for LPS (Limited Power Supply) of CAN/CSA-C22.2 No. 60950-1 or a circuit supplied by a source with no direct electrical connection between input and output, such as provided by a transformer or optical isolator, and with output parameters as follows:
 - (a) source with a maximum output voltage of 42.4 V peak ac (30 V rms) or 60 V dc; and
 - (b) a maximum output current limited to values specified in [Tables A.1](#) and [A.2](#).
- (2) For the purposes of this Standard, LVLE complying with [Annex A](#) are deemed to be equivalent to Class 2 controlgear in respect to electric shock and fire and are marked as suitable for use in Class 2 circuits.

Circuit, safety extra low voltage (SELV) — a circuit that exhibits voltages that are safe to touch under normal operating conditions and after a single fault.

Note: SELV circuit complies with the requirements of the CAN/CSA-C22.2 No. 60950 or supplied by a source with no direct electrical connection between input and output, such as that provided by a transformer or optical isolator, and with output parameters as follows:

- (a) Voltages under normal conditions cannot exceed 42.4 V peak (30 V rms), or 60 V dc.
- (b) Voltages under fault conditions cannot exceed 42.4 V peak, or 60 V dc, for longer than 0.2 s. Moreover, a limit of 71 V peak, or 120 V dc, cannot be exceeded.

Enclosure, electrical — a part of the equipment intended to limit access to components that are operating at voltage levels in excess of Class 2, LVLE, or SELV level.

Enclosure, fire — a part of the equipment that is intended to minimize the spread of fire from within a product to components that are operating at energy levels in excess of Class 2, LVLE, or SELV 240 VA level.

Environmental locations —

Dry location — a location not normally subject to dampness, but that could be subject to temporary dampness.

Note: An example is a building under construction, provided ventilation is adequate to prevent an accumulation of moisture.

Damp location — an exterior or interior location that is normally or periodically subject to condensation of moisture in, on, or adjacent to, electrical equipment.

Note: Includes partially protected locations.

Wet location — a location where water can drip, splash, or flow onto, or against, electrical equipment.

Insulation-piercing terminal — a terminal having a contact pin that punctures the conductor insulation and penetrates between the conductor strands.

Isolated output — a circuit that contains only magnetic, capacitive, or optical connection to any ground-referenced supply source.

Note: A low voltage circuit derived by a dropping resistor is not isolated.

LED (light emitting diode) — a solid-state component that contains a p-n junction and emits optical radiation when excited by an electric current.

LED array (LED module) — an assembly of one or more LED discrete electronic components on a printed wiring board, that typically contains optics and additional thermal, mechanical, and electrical interfaces.

LED control module (LED controller) — electronic circuitry interposed between the power source and an LED array to dim, switch, or otherwise control the electrical energy to the LED array.

Note: The device does not contain a power source and is not connected directly to the branch circuit.

LED controlgear — a power source that adjusts the voltage or current to LEDs, ranging in complexity from a resistor to a constant voltage or constant current power supply.

Note: LED controlgear is also referred to as LED driver (see also **Power source**).

LED package — an assembly of one or more LED die that contains wire bond connections and can include an optical element and thermal, mechanical, and electrical interfaces.

Note: The package does not include a power source and is not connected directly to the branch circuit.

Measurement indication unit (MIU) — the rms equivalent value of a 60 Hz sinusoidal leakage current in milliamps (mA), adjusted to compensate as necessary for leakage currents composed of complex waveforms or frequencies other than 50 or 60 Hz.

Note: MIU is determined by dividing the output voltage (V_3) in millivolts (mV) rms by 500 (the value in ohms of the resistance in parallel with V_2) in the measurement instrument circuit shown in [Figure 5](#).

Part, dead conductive — a conductive part with or without basic insulation that, under normal operating conditions, carries no electrical current.

Note: A grounded dead conductive part may carry only leakage current.

Part, hazardous live — a part located in a circuit that is operating in excess of what is considered the risk of electric shock or the risk of fire limits.

Part, live — a conductive part that has an electrical difference of potential with respect to earth ground or any other conductive part.

Note: A part connected to a grounded supply (neutral) conductor is considered to be a live part.

Performance level characteristic (PLC) value — an integer that defines a range of test values for a given electrical/mechanical property test for polymeric (plastic) materials, as defined in CAN/CSA-C22.2 No. 0.17.

Power source, class 2 — an electrical source, e.g., a transformer or power supply, that complies with the requirements of CAN/CSA-C22.2 No. 223 or both CSA C22.2 No. 66.1 and CSA C22.2 No. 66.3.

Power source, isolated low voltage limited energy (LVLE) — a source as defined in Circuit, isolated low voltage limited energy.

Power supply — an electronic device capable of controlling current, voltage, or power within its design limits.

Risk of electric shock — a risk of shock exists between any two uninsulated conductive parts or between an uninsulated conductive part and earth ground, if the continuous current flow through the circuit described in [Figure 5](#) connected between the two points exceeds a 5 mA rms (7 mA peak) and if the open circuit voltage exceeds 30 V rms (42.4 V peak) or 60 V dc for dry and damp or 15 V rms (21.2 V peak) or 30 V dc for wet locations.

Risk of fire — a risk of fire exists in all electrical circuits except:

- (a) a Class 2 circuit;
- (b) an LVLE circuit; or
- (c) a SELV circuit less than 240 VA that complies with abnormal tests without presenting any sign of fire hazard.

Unit — any discrete device, subassembly, or assembly.

Unit, fixed — a unit intended to be permanently connected electrically to the wiring system.

Unit, portable — a unit that is easily carried or conveyed by hand, and is provided with a power-supply cord for connection to the supply circuit.

Unit, stationary — a unit that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

4 General requirements

4.1 General

General requirements applicable to this Standard are given in CSA C22.2 No. 0.

4.2 Components

The components in products covered by this Standard shall comply with the requirements for those components. See [Annex D](#) for a list of standards covering components used in the products covered by this Standard.

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

- (a) involves a feature or characteristics 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.

4.3 Units of measurement

Wire sizes in this Standard are in American wire gauge (AWG) and values of voltage and current, unless otherwise indicated, are true root mean square (rms) values.

5 Software safety function

5.1

Products that use safety functions shall be investigated with the same safety testing related to a single fault fire hazard, shock hazard, or energy hazard. In addition, a risk assessment shall be prepared to review software safety functions and the mitigation measurements to prevent them from experiencing a single fault failure. CSA C22.2 No.0.8 shall be used for evaluation to investigate the safety functions.

5.2

All functional safety analysis shall include

- (a) a list of the safety functions involved;
- (b) a risk assessment; and
- (c) a description of the mitigation measurements introduced to mitigate the risks identified.

6 Environmental locations

6.1

A unit intended exclusively for dry locations shall be identified as such, and shall not be provided with any information (e.g., markings, instructions, or illustrations) that implies or depicts damp or wet use.

6.2

A unit intended for damp locations shall be

- (a) subjected to the environmental tests specified in [Clause 9.12](#) unless all live parts and traces on the printed wiring board are potted (see [Clause 7.7](#)) or conformal coated (see [Clause 8.7.2](#)); and
- (b) be marked as suitable for damp or dry locations and not be provided with any information (e.g., markings, instructions, or illustrations) that implies or depicts wet use.

6.3

A unit intended for use in wet locations shall

- (a) be subjected to the environmental tests specified in [Clause 9.12](#) unless all live parts and traces on the printed wiring board are potted (see [Clause 7.7](#)) or conformal coated (see [Clause 8.7.2](#));
- (b) if provided with a polymeric enclosure, comply with the weatherometer test specified in CAN/CSA-C22.2 No. 0.17;
- (c) if provided with a polymeric enclosure, three samples shall comply with the physical abuse test specified in CAN/CSA-C22.2 No. 0.17, immediately after 3h conditioning at -35 ± 2.0 °C ambient temperature; and
- (d) be marked as suitable for wet locations.

7 Mechanical construction

7.1 General

7.1.1

A unit intended for use in an application identified by one of the standards specified in [Clause 1.3.1](#) shall comply with the mechanical construction requirements of that standard. If an end-use application is not specified or identified, or if a particular construction feature is not covered by the standard, the unit shall comply with the mechanical construction requirements specified in [Clause 7](#).

7.1.2

A unit's enclosure shall prevent contact with uninsulated parts that pose a risk of electric shock, contain any fire initiated within the unit, and prevent mechanical damage to internal parts.

7.1.3

Circuits that pose a risk of electric shock or fire shall be provided with an enclosure that complies with [Clause 7.2](#) or [7.3](#).

7.1.4

Circuits that do not pose a risk of electric shock or fire are not required to be provided within an enclosure. Circuits operating within Class 2 or LVLE levels also need not be enclosed.

7.1.5

An adhesive used to secure the enclosure of a product that poses a risk of electric shock or fire shall comply with the adhesive support test specified in [Clause 9.11](#). Fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding are permitted without the test.

7.2 Metal thickness

7.2.1

The thickness of a metal enclosure shall be in accordance with Clause 5.5 of C22.2 No 250.0.

Note: A part of an enclosure that complies with the mechanical strength tests for metal enclosures specified in [Clause 9.13](#) need not comply with the requirements in this Clause.

7.2.2

All ferrous metal parts (e.g., hinges, bolts, and fasteners) exposed after assembly shall be protected against corrosion by painting, coating, or plating, except for edges, punched holes, and spot welds in prefinished steel, enclosed steel pipe, and hanger locations for painting or plating. Copper, aluminum, copper and aluminum alloys, stainless steel, and similar materials having inherent resistance to atmospheric corrosion are not required to have additional corrosion protection.

7.2.3

A protective coating is not required to be applied to steel enclosure parts when

- (a) the interior of an enclosure is completely filled with potting compound;
- (b) flat metal surfaces are tightly clamped together; or
- (c) it is not practical due to bearings, sliding surfaces of a hinge or shaft, hinge pins, and similar parts.

7.3 Polymeric material for enclosures and electrical insulation

7.3.1

Polymeric material shall have an electrical, mechanical with impact and mechanical with strength relative thermal index (RTI), or a generic thermal index as specified in CAN/CSA-C22.2 No. 0.17, that is equal to or greater than the temperature measured during the temperature test specified in [Clause 9.3](#).

7.3.2

Polymeric material that is used as an enclosure shall comply with the material characteristic requirements specified in [Table 1](#) based on the specific application.

Table 1
Polymeric enclosure requirements
 (See [Clauses 7.3.2](#) and [7.3.5](#).)

Performance characteristic	Power source		
	Class 2 & LVLE	SELV	Direct connected
Enclosure Type Needed	None	Fire only ^{††}	Fire and Electrical
Relative Temperature Index (RTI)	No	Yes	Yes
Physical abuse — Sphere impact	No	Yes*	Yes*
Physical abuse — Drop test	No	Yes [†]	Yes [†]
Physical abuse — Sphere impact with pre-conditioning [‡]	No	Yes [‡]	Yes [‡]
Weatherometer (UV resistance)	No	Yes [§]	Yes [§]
Flammability	No	5 VA**, ^{††} , ^{‡‡} §§	5 VA**, ^{††} , ***
Mould Stress	No	Yes	Yes
Comparative tracking index (CTI)	No	No	PLC of 4 ^{††††}
Hot wire ignition, (HWI)	No	No	PLC of 3 ^{††††}
High ampere arc (HAI)	No	No	PLC of 2 ^{††††}

*Sphere, 6.8 J (5 ft-lb), impact for dry or damp location, fixed or stationary units.

[†]Drop test, 1 m (3.28 ft), impact for portable units.

[‡]For damp or wet location, fixed units, to be conducted on three samples after cold conditioning in accordance with CAN/CSA-C22.2 No. 0.17 immediately after conditioning for 3 h in either a 0 ± 2.0 °C ambient temperature (for damp location units) or minus 35 ± 2.0 °C ambient temperature (for wet location units).

[§]For wet location units.

**V2 for portable units and track lighting luminaires.

^{††}V1 for the lens (optic) of an LED package.

^{‡‡}No fire enclosure requirement where there is no risk of fire hazard after abnormal tests and where the available energy is below 240 VA.

^{§§}HB when there is no risk of fire hazard after abnormal tests.

***HB when there is no risk of fire hazard after abnormal tests — applicable only to LED circuits.

^{††††}Not required when all live parts are spaced at least 0.8 mm from the material.

7.3.3

Flaking or peeling of a conductive coating applied to a surface such as the inside surface of a cover, enclosure, and the like shall not result in a reduction of spacing of electrical parts or the bridging of live parts that might result in a risk of fire or electric shock.

7.3.4

The lens (optic) of an LED package connected in a circuit that poses a risk of electric shock is not required to be provided within an enclosure if made of

- glass; or
- a polymeric material that complies with the dielectric voltage withstand test specified in [Clause 9.4](#) when a 500 V potential is applied between the electrical connections to the LED and the lens surface.

7.3.5

The lens (optic) of an LED package connected in a circuit that poses a risk of fire is not required to be provided within an enclosure if it is made of a material having a flammability rating as specified in footnote ^{††} of [Table 1](#).

7.3.6

An electrical enclosure is not required for live parts coming from Class 2, LVLE, or SELV circuits, as they do not present a risk of electric shock. Notwithstanding, live parts coming from SELV circuits shall comply with a maximum touch current as per the definition of Risk of electric shock in [Clause 3](#) after single abnormal tests.

7.3.7

A fire enclosure is not required for parts supplied from Class 2, LVLE, or SELV circuits, as they do not present a risk of fire. Notwithstanding, the lighting equipment or its parts supplied from SELV circuits shall have an energy level less than 20 J or 240 VA, and shall comply with the abnormal tests without presenting any sign of fire hazard.

7.3.8

A fire enclosure is required for parts supplied from either SELV or line voltage that exceed an energy level of 20 J or 240 VA. Direct connected and SELV LED circuits exceeding 20 J or 240 VA, that comply with abnormal tests without presenting any sign of fire hazard, may have a fire enclosure having a minimum flammability rating of HB.

7.4 Enclosure openings

7.4.1

The surface of a fire or electrical enclosure shall not contain open holes, other than for supply connections.

Note: *An open hole is permitted in an enclosure that is intended for installation on or over an outlet box when the outlet box will serve to complete the enclosure.*

7.4.2

Open holes and openings shall comply with the requirements of Section 10, Clause 10.4 of CSA 250.0.

7.5 Conductor protection

Conductors that pass over edges or through openings in metal shall be secured to prevent them from contacting the edges or shall be protected from cutting and abrasion. For sheet metal less than 1.1 mm (0.042 in) thick, protection shall be provided by one of the following methods:

- (a) rolling the edge of the metal not less than 120°;
- (b) a bushing or grommet of a material other than rubber at least 1.2 mm (0.047 in) thick; or
- (c) glass sleeving at least 0.25 mm (0.010 in) thick.

7.6 Strain relief

For accessible conductors operating above Class 2 or LVLE limits, a strain relief and cord push back means shall be provided that complies with the cord strain pushback relief test requirements specified in [Clause 9.8](#), where cord or lead wire displacement could result in

- (a) the supply cord or lead being subjected to mechanical damage;
- (b) the supply cord or lead being exposed to a temperature higher than that for which it is rated;
- (c) spacing (such as to a metal strain-relief clamp) being reduced below the minimum required values; or
- (d) damage to internal connections or components.

Note: *A conductor embedded in an epoxy potting compound inside the enclosure at the cord entrance is considered to be equipped with the necessary strain relief.*

7.7 Potting compound

7.7.1

Potting compound shall not leak, drip, or be released from a unit while under condition of testing and shall not exceed its relative thermal index (RTI) while the temperature test specified in [Clause 9.3](#) is being conducted.

7.7.2

Asphalt potting compound shall remain at least 15 °C below its softening point, as specified in ASTM E28.

8 Electrical construction

8.1 General

8.1.1

A unit intended to be used in an application covered by the standards specified in [Clause 1.3.1](#) shall comply with the electrical construction requirements of the relevant standard. If an end-use application is not specified, or if a particular construction feature is not covered by the relevant standard, the unit shall comply with the electrical construction requirements of [Clause 8](#).

8.1.2

A current-carrying part shall be silver, copper, copper alloy, plated iron or steel, stainless steel, or other corrosion-resistant alloys acceptable for the application.

8.1.3

An uninsulated live part shall be secured to prevent it from turning or shifting if such motion results in a reduction of spacings below the minimum acceptable values.

8.1.4

Friction between surfaces shall not be used as a means to prevent shifting or turning of a live part, but a lock washer is acceptable.

8.2 Accessibility

8.2.1

A live part that presents a risk of electric shock shall be located so it is inaccessible to contact using the articulate probe shown in [Figure 1](#), applying a force not exceeding 4.45 N (1 lbf).

8.2.2

A part that can be removed without using a tool shall be removed when determining accessibility to the probe.

8.2.3

An insulating barrier used to prevent access to live parts shall be at least 0.71 mm (0.028 in) thick.

8.2.4

An insulating barrier used in conjunction with at least half the required spacing through air may be less than 0.71 mm (0.028 in) thick, but not less than 0.33 mm (0.013 in) thick if the barrier or liner is of insulating material that is

- (a) resistant to moisture;
- (b) of acceptable mechanical strength if exposed or otherwise likely to be subjected to mechanical damage;
- (c) reliably held in place; and
- (d) located so that it is not adversely affected by operation of the device, particularly arcing.

8.2.5

An insulating barrier in the secondary circuit where the potential is not more than 50 V may be less than 0.71 mm (0.028 in) thick, but not less than 0.25 mm (0.010 in) thick if it is

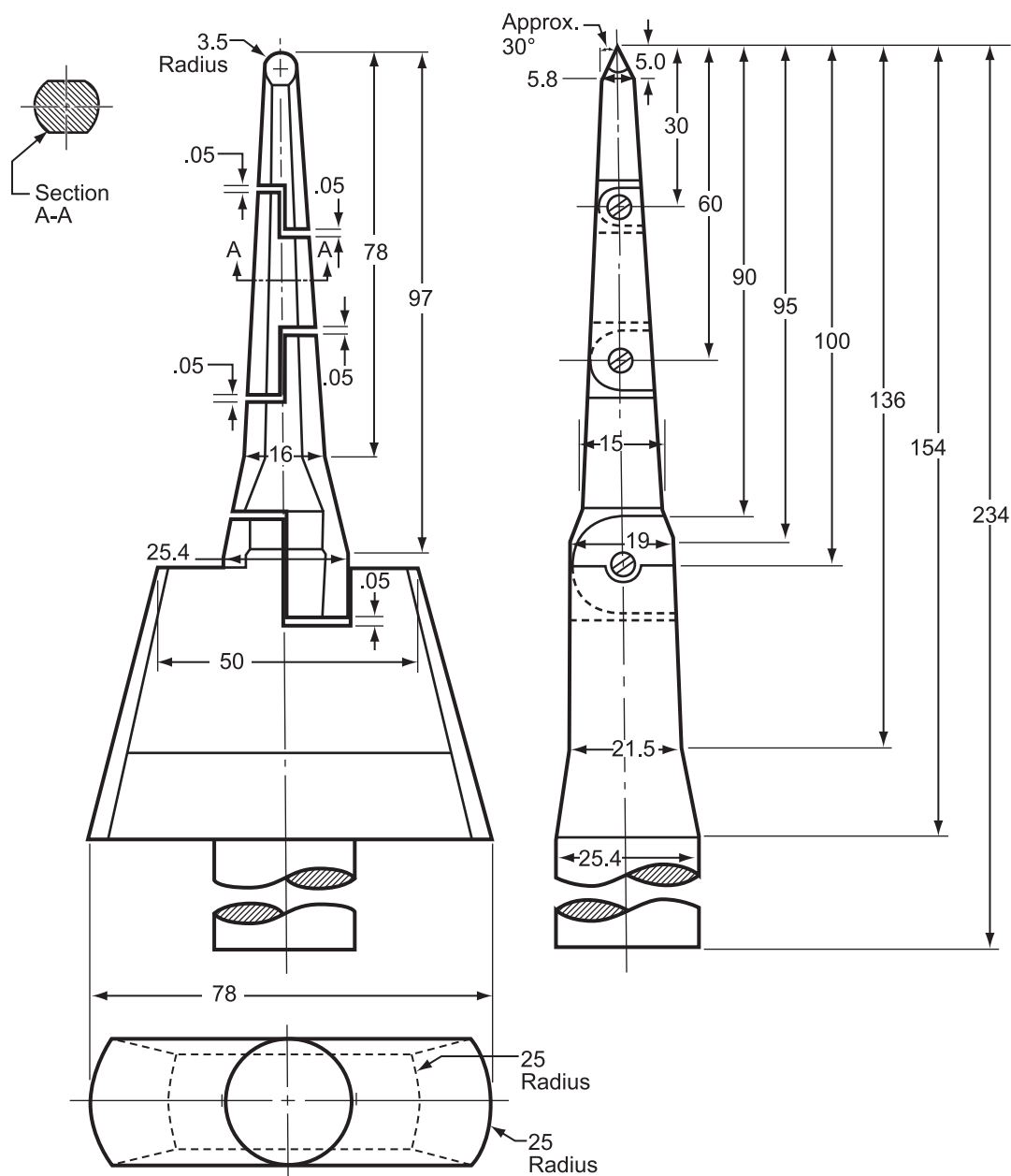
- (a) resistant to moisture;
- (b) of acceptable mechanical strength if exposed or otherwise likely to be subjected to mechanical damage; and
- (c) reliably held in place.

8.2.6

An insulating barrier may have a thickness less than 0.71 mm (0.028 in) if it is evaluated separately as an internal barrier and found to have insulating characteristics equivalent to 0.71 mm (0.028 in) thick vulcanized fibre.

8.3 Internal wiring**8.3.1**

Internal wiring shall consist of insulated conductors having the mechanical strength, dielectric voltage withstand properties, and ampacity required for the application.

**Notes:**

- (1) All dimensions are in millimetres.
- (2) The articulate probe without the web stop may be used for openings having a minor dimension less than 19.1 mm (0.75 in).

Figure 1
Articulate probe with web stop
 (See [Clauses 8.2.1](#) and [E.2.3.](#))

8.3.2

Each splice and connection shall be secured mechanically, provide reliable electrical contact, and be provided with insulation at least equivalent to that of the voltage used unless acceptable permanent spacing is maintained between the splice and all other uninsulated current-carrying parts at different potentials and non-current-carrying metal parts.

8.3.3

The electrical and mechanical connection between a conductor and any circuitry operating above Class 2 or LVLE limits shall be contained within an enclosure and be inaccessible in accordance with [Clause 8.2](#).

8.3.4

Soldered connections shall be mechanically secured before soldering or comply with at least one of the following acceptable methods:

- (a) wave soldered connection;
- (b) covered by two part epoxy or the equivalent;
- (c) a conductor passing through a hole on printed circuit board;
- (d) surface mount device (SMD) components and small components without integral leads are not required to be mechanically secured to the printed circuit board prior to soldering;
- (e) surface mounted connector receptacles and associated connectors with leads considered acceptable without being mechanically secure in applications where the lead wires are not subjected to movement after assembly;
- (f) the connection of a wire held rigidly in place without the use of solder to preclude any movement at the point of electrical connection; or
- (g) a connection in a Class 2 or LVLE circuit where detachment will not result in reduced spacings to circuit other than Class 2 or LVLE.

Note: A soldered connection supplied by a Class 2 or LVLE source does not require additional mechanical securement if detachment will not reduce spacings to non-Class 2 or non-LVLE circuits below the applicable required spacings specified in [Clause 8.8](#).

8.3.5

Conductors shall be minimum 18 AWG (0.82 mm²), except as specified in [Clause 8.3.7](#), and shall be rated for the voltage, current, temperature, and conditions of service for normal operation.

8.3.6

Conductors of a size smaller than 18 AWG (0.82 mm²), but no smaller than 24 AWG (0.21 mm²), may be used under the following conditions:

- (a) where they are completely enclosed;
- (b) where they are not subject to movement under normal use; and
- (c) in the secondary of a transformer or in a circuit containing solid-state devices.

8.3.7

Conductors smaller than 24 AWG (0.21 mm²) may be used only when they are in Class 2 or isolated LVLE circuits and are physically separated from all other non-Class 2 or non-isolated LVLE circuits (e.g., by a barrier or reliably fixed minimum spacing of 6.4 mm (0.25 in)).

8.4 Supply and load connections

8.4.1 General

8.4.1.1

Input and output wiring shall comply with the requirements for internal wiring as specified in [Clause 8.3](#) in addition to the applicable requirements specified in [Clause 8.4](#).

8.4.1.2

Power limited circuit wiring that is intended to be external to a unit and be routed within a building structure shall be of a type suitable for the application such as LVT, CMP, CMR, CMG, CM, CMX, CMH, or CMUC, and in accordance with the requirements of CSA C22.2 No. 214 or CSA C22.2 No. 35. The minimum conductor size shall be

- (a) No. 19 AWG for a cable with two or more conductors;
- (b) No. 22 AWG for a cable with four or more conductors;
- (c) No. 24 AWG for a cable with six or more conductors; and
- (d) No. 26 AWG for a cable with ten or more conductors.

The maximum allowable current shall be as specified in the Table below:

Size, AWG	Allowable ampacities for copper conductors (A)
26	1
24	2
22	2.5
20	3.5
19	4
18	5

Note: Cable LVT is not available below 22 AWG.

8.4.1.3

Communication cables types MPP, CMP, MPR, CMR, MPG, CMG, MP, CM, CMX, CMH may be used for wiring extra low voltage Class 2 circuits provided

- (a) only types MPP and CMP are used in locations where a FT6 flame spread rated cable is required by the *National Building Code of Canada*; and
- (b) only types MPP, CMP, MPR, CMR, MPG and CMG are used in locations where a FT4 flame spread rated cable is required by the *National Building Code of Canada*.

Note: The subject cables are tested for 300 V insulation but do not carry a voltage rating. Cable types MPP, CMP, MPR, CMR, MPG, CMG, MP, CM, CMX, and CMH have been found to have a flame spread rating equal or greater than FT1. Cable types MPP, CMP, MPR, CMR, MPG, and CMG have been found to have a flame spread rating equal or greater than FT4.

8.4.1.4

Luminaires designed or intended to accommodate conductors for external wiring of power limited circuits which is not intended for a building of combustible construction shall be provided with a means to accommodate an approved raceway.

8.4.2 Permanently-connected units

8.4.2.1 Conduit connection

8.4.2.1.1

A unit intended to be connected to a branch circuit in accordance with the *Canadian Electrical Code, Part I* shall be provided with either field-wiring leads complying with [Clause 8.4.2.2](#) or field-wiring terminals complying with [Clause 8.4.2.3](#).

8.4.2.1.2

A means for conduit connection shall be provided for connection to a permanent wiring system.

8.4.2.1.3

Unthreaded openings for the conduit and the area surrounding the opening shall comply with the requirements specified in [Table 2](#).

Table 2
Dimensions of unthreaded openings for conduits and diameter of the area surrounding the opening

(See [Clauses 8.4.2.1.3](#), [8.4.2.1.4](#), and [A.10](#).)

Nominal trade size of conduit	Unthreaded opening diameter*		Minimum unobstructed diameter of flat surface surrounding conduit opening on interior of opening	
	in	mm (in)	mm	(in)
1/2	22.2	(0.875)	28.09	(1.11)
3/4	28.2	(1.109)	34.04	(1.34)
1	34.9	(1.375)	42.85	(1.69)
1-1/4	44.0	(1.734)	55.07	(2.17)

*A plus tolerance of 0.81 mm (0.032 in) and a minus tolerance of 0.38 mm (0.015 in) applies to the knockout diameter. Knockout diameters are to be measured other than at points where a tab attaches the knockout.

8.4.2.1.4

A threaded opening for a conduit shall comply with [Table 3](#). When tapped all the way through, the opening shall have at least 3.5, but no more than 5, threads and comply with the minimum unobstructed diameter of a flat surface specified in [Table 2](#) to accommodate the conduit bushing. When not tapped all the way through, the opening shall have at least 5 threads.

Table 3
Throat diameters for conduit openings
 (See [Clause 8.4.2.1.4.](#))

Nominal trade size of conduit	Minimum throat diameter		Maximum throat diameter	
	mm	(in)	mm	(in)
1/2	13.4	(0.528)	15.8	(0.622)
3/4	17.7	(0.697)	20.8	(0.819)
1	22.4	(0.882)	26.7	(1.051)
1-1/4	29.7	(1.169)	35.1	(1.382)

8.4.2.1.5

A unit provided with a means of conduit connection shall be shipped with provision to close all but one of the conduit openings.

8.4.2.1.6

Unless provided with a safely separated wiring compartment, an opening intended for making field connections to a branch circuit supply shall be located more than 152 mm (6 in) from the following:

- (a) uninsulated live parts;
- (b) low voltage circuitry;
- (c) heat-producing components;
- (d) moving parts; and
- (e) any other electrical or mechanical component not specified above that could result in an increased risk of fire or electric shock.

8.4.2.1.7

The area adjacent to an opening where branch circuit supply connections are to be made in the field, and which has components located within 152 mm (6 in) of the opening, shall be enclosed within a wiring compartment that has a volume of at least 98 cm³ (6 in³).

8.4.2.1.8

A field-wiring compartment intended for connection of a wiring system shall be attached to the unit in a manner that will prevent it from turning.

8.4.2.1.9

An outlet box, terminal box, wiring compartment, or the like in which connections to the unit will be made in the field shall be free from any sharp edges, e.g., screw threads, burrs, fins, moving parts, etc., that may abrade the conductors' insulation or damage the wiring.

8.4.2.1.10

The minimum volume of an integral field-wiring compartment for branch circuit connections shall be determined using [Table 4](#). All conductors entering or leaving the compartment shall be included in the calculation. Uninsulated grounding or bonding conductors integral to the unit shall not be included. Field wiring shall assume size 12 AWG (1.64 mm²) conductors are used unless the ampacity of the unit requires larger conductors.

Table 4
Determination of minimum wiring compartment volume
 (See [Clause 8.4.2.1.10.](#))

Wire size	Conductor volume	
AWG	cm ³	(in ³)
18	8.2	(0.5)
16	9.8	(0.6)
14	12.3	(0.75)
12	16.4	(1.0)
10	27.9	(1.7)

8.4.2.2 Field-wiring leads

8.4.2.2.1

A field-wiring lead intended for connection to the branch circuit shall be a minimum of 18 AWG (0.82 mm²).

8.4.2.2.2

A field-wiring lead's length shall be at least 152 mm (6 in). If a wiring compartment is provided, the free length shall be measured from the point of entry of the lead through the wiring compartment to the free end.

8.4.2.2.3

Insulation of a lead intended for the connection of a grounded conductor (common or neutral) shall be white or gray throughout its length.

8.4.2.2.4

Insulation of a lead intended for the connection of an ungrounded (hot) conductor shall be any colour other than white, gray, green, or green with a yellow stripe.

8.4.2.2.5

A lead intended for the connection of a grounding conductor shall be bare (i.e., with no insulation) or shall be green or green with a yellow stripe.

8.4.2.3 Field-wiring terminals

8.4.2.3.1

A pressure wire-type terminal or a wire binding screw shall be suitable for field wiring.

8.4.2.3.2

A terminal intended for the connection of a grounded conductor of an ac supply shall be largely white or silver in coloured metal or shall be marked with the words "NEUTRAL", "N", "W" or "White". No other terminal shall be largely white or silver coloured.

8.4.2.3.3

A terminal intended for the connection of a grounding conductor shall have a green coloured head or the area directly adjacent to the terminal shall be marked with a grounding symbol or abbreviation (i.e., G, GR, GRD, GND, GRND, or GROUND) or the symbol Ⓜ(IEC 60417-1, Symbol 5019).

8.4.2.3.4

A terminal intended for the connection of a dc supply, where polarity of the supply connection is required, shall be marked with the symbols “–” and “+” on or immediately adjacent to the supply terminals.

8.4.2.3.5

Where dislocation of a secured lead wire can result in a risk of electric shock or a reduction of required spacings, a terminal plate tapped for a wire-binding screw or stud shall be of brass or other nonferrous metal, or plated steel. It shall be at least 0.76 mm (0.030 in) thick and shall provide a minimum of two full threads in the metal for the binding screw.

Notes:

- (1) Two full threads are not required if a lesser number of threads results in a secure connection in which the threads do not strip when subjected to the tests and requirements of the security of output terminals test specified in [Clause 9.9](#).
- (2) A plate may be less than 0.76 mm (0.030 in) thick if the tapped threads have acceptable mechanical strength, as determined by the security of output terminals test specified in [Clause 9.9](#).

8.4.2.3.6

A wire-binding screw or terminal stud shall be a minimum of 3.5 mm (0.138 in) in diameter (No. 6) and shall not have more than 32 threads per 25.4 mm (1 in). The screw or stud shall be of brass, brass alloy, or plated iron or steel.

8.4.2.3.7

Terminal studs shall be prevented from turning by means other than friction between mounting surfaces. The acceptability of a lock washer or similar means to prevent turning shall be determined by conducting the security of output terminals test specified in [Clause 9.9](#).

8.4.2.4 Push-in terminals

8.4.2.4.1

A push-in wiring terminal for the connection of supply leads shall allow only for the termination of the branch circuit conductor supplying the power source. It shall not provide for additional connections, unless the push-in wiring terminal has been evaluated to handle full branch circuit current.

8.4.2.4.2

A push-in wiring terminal shall not rise to a temperature exceeding 30 °C during the temperature test specified in [Clause 9.3](#).

8.4.2.4.3

A unit that employs push-in terminals shall be marked in accordance with [Clause 10.3.1](#).

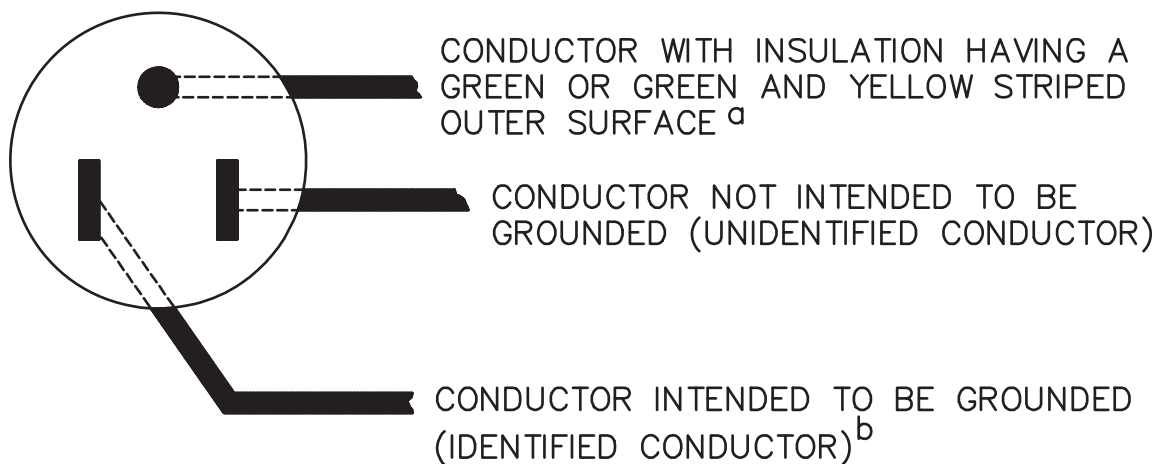
8.4.3 Cord-connected and direct plug-in units

8.4.3.1

A unit not intended for permanent connection to a branch circuit source of supply shall be provided with either

- (a) a cord-connected or direct plug-in power supply, with an output cord for mating with the unit; or
- (b) a power supply cord and integral polarized or grounding-type attachment plug, as shown in [Figure 2](#).

CONNECTIONS OF CORD CONDUCTORS TO GROUNDING — TYPE ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



CONNECTIONS OF CORD CONDUCTORS TO POLARIZED ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)

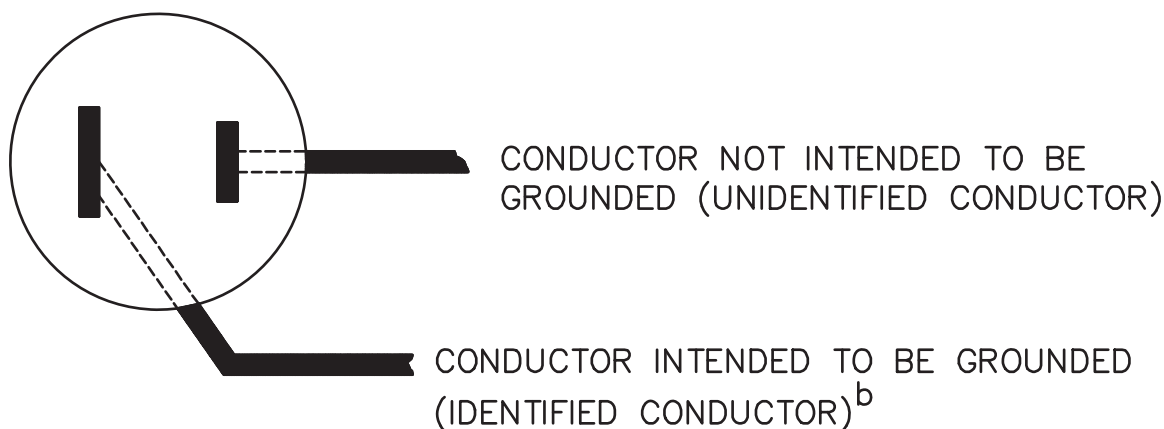


Figure 2
Connection to attachment plug

(See [Clause 8.4.3.1.](#))

8.4.3.2

A three-conductor flexible cord with ground shall be provided with conductor identification that shows grounded and grounding conductors. A jacketed cord, such as an SJT-type, shall have the grounding conductor within the jacket coloured green or green with a yellow stripe and the grounded conductor shall be coloured white or gray.

8.4.3.3

A component without accessible dead metal parts is not required to be provided with a grounding-type supply cord when it is identified for use in an end-product that has no dead metal needing to be grounded, or exclusively for use in an end-product (e.g., portable luminaires) that does not require grounding under certain uses.

8.4.3.4

When a two-conductor flexible cord is provided for connection to the source of supply and polarity is required, the conductors shall be connected to a polarized parallel-blade attachment plug with the identified grounded conductor (neutral) connected to the wider blade. The parallel cord (e.g., Type SPT-2) shall have a stripe, ridge, or groove on the exterior of the cord surface of the grounded (neutral) conductor for identification.

8.4.3.5

The power supply cord shall be a minimum of 18 AWG (0.82 mm²).

8.4.3.6

The power supply cord provided on a unit designated for dry locations only shall be Type SP-2, SPE-2, SPT-2, or heavier. The power supply cord on a product intended for use in wet locations shall also be rated for outdoor use with the following surface marking: "W" or "Water Resistant."

8.4.3.7

The power supply cord shall be a minimum of 1.5 m (5 ft) in length. The length shall be measured from the point where the cord emerges from the unit, after any strain-relief means provided, to the point where the cord enters an attachment plug.

8.4.3.8

If a flexible power supply cord has a knot that serves as strain relief, the surface that the knot contacts or bears shall not have burrs, fins, sharp edges, and projections that could damage the cord's insulation.

8.4.3.9

The power supply cord shall be provided with a bushing at the point where the cord passes through the opening in a metal enclosure or through a non-rounded opening in a polymeric enclosure. The bushing shall be secured in place and have a smooth, rounded surface against which the cord bears. The bushing shall be nonmetallic if the cord is Type SVT or lighter.

8.4.3.10

A cord-connected unit's attachment plug shall be configured for a 15- or 20-A branch circuit receptacle and shall comply with either the requirements specified in CSA C22.2 No. 42 or CSA C22.2 No. 21, or both.

8.4.4 Leads, terminals, and connectors for other than branch circuit connections**8.4.4.1 General**

Input and output leads, terminals, and connectors shall be rated for the appropriate voltage, current, and temperature.

8.4.4.2 Leads

Input and output leads shall comply with the requirements for internal wiring specified in [Clause 8.3](#) and shall be of sufficient length to allow for the intended connection.

8.4.4.3 Output connectors

8.4.4.3.1

A unit with multiple Class 2 or LVLE supply or load connections, where interconnection could cumulatively exceed Class 2 or LVLE limits, shall be provided with polarized connectors that inhibit such interconnection.

8.4.4.3.2

Output connectors mounted on the enclosure, and intended for direct connection of accessories, shall provide a secure connection between mating parts. The connections shall be polarized if the output is direct current or if multiple outputs are provided.

8.4.4.3.3

Coaxial cable connectors shall not be used for output connections.

8.4.4.4 Insulation-piercing connections

8.4.4.4.1

Units employing insulation-piercing terminals intended for use with flexible cord or stranded conductor wire operating above Class 2 or LVLE limits shall be for factory assembly only.

8.4.4.4.2

Flexible cord and wire for insulation-piercing connections shall be rated a minimum of 105 °C.

8.4.4.4.3

Units operating above Class 2 or LVLE limits, and intended for insulation-piercing connections, shall be subjected to the insulation-piercing connection thermal cycling conditioning test specified in [Clause 9.10](#) and comply with the temperature test specified in [Clause 9.3](#).

8.5 Separation of circuits

8.5.1

Insulated conductors of different circuits that might come into contact with each other, including wires in a terminal box or compartment, shall have insulation rated for the highest of the circuit voltages or shall be separated by a minimum of 6.44 mm (0.25 in).

8.5.2

Where units have field-installed connections for Class 2 or LVLE circuits inside the enclosure wiring compartment, the minimum 6.44 mm (0.25 in) separation from non-Class 2 or LVLE circuits shall be provided by means of separate entries for Class 2 or LVLE and non-Class 2 wiring, by the safe routing of the conductors within the unit, or by the effective use of barriers.

8.5.3

Segregation of insulated conductors can be accomplished by clamping, routing a barrier, or equivalent means that provide safe separation from insulated or uninsulated live parts of a different circuit.

8.5.4

A barrier used to separate power limited wiring from branch circuit wiring in a field wiring compartment shall be made of

- (a) a minimum of 0.4 mm (0.016 in) thick metal bonded to other grounded parts of the luminaire;
- (b) a minimum of 0.7 mm (0.028 in) thick vulcanized fibre;
- (c) a minimum of 0.7 mm (0.028 in) thick moulded polymeric material with a temperature rating suitable for the temperature to which they will be subjected;
- (d) glass or ceramic at least 3 mm (0.118 in) thick; or
- (e) impregnated glass fibre sleeving at least 0.25 mm (0.010 in) thick that is rated for the temperature to which they will be subjected.

8.6 Insulating materials

8.6.1

Integral parts, such as insulating washers and bushings, as well as bases or supports for mounting live parts, shall be comprised of moisture-resistant materials that are not damaged by the temperatures and stresses to which they are subjected under conditions of actual use.

8.6.2

Insulating materials shall be evaluated for their intended applications in accordance with CAN/CSA-C22.2 No. 0.17 with respect to:

- (a) mechanical strength;
- (b) resistance to ignition sources;
- (c) dielectric strength;
- (d) insulation resistance;
- (e) heat-resistant properties in both the aged and unaged conditions;
- (f) the degree to which the insulating material is enclosed;
- (g) resistance to moisture if the unit is rated for other than dry locations; and
- (h) any other features affecting the risk of fire and electric shock.

Note: Materials such as mica, ceramic, or some molded compounds are usually acceptable for use as the sole support of live parts.

8.7 Printed wiring boards

8.7.1

Printed wiring boards shall meet the following criteria:

- (a) Conductive traces shall be bonded to the substrate for the minimum conductor width and maximum unpierced area, as required by CAN/CSA-C22.2 No. 0.17.

Note: Printed-wiring boards that are completely encased in potting compound may exceed their specified minimum conductor width or maximum unpierced area.

- (b) Temperatures measured in the temperature test specified in [Clause 9.3](#) shall not exceed the temperature rating (RTI) of the substrate, as determined by CAN/CSA-C22.2 No. 0.17.
- (c) Printed wiring board substrate flammability shall be a minimum of V-1, in accordance with CAN/CSA-C22.2 No. 0.17.

Note: A circuit supplied by a Class 2 or LVLE source need not comply.

8.7.2

Where a conformal coating is used to qualify for spacing reductions per the specifications of [Clause 8.8.2](#), the conformal coating shall comply with the requirements in [Annex C](#) and be suitable for use in combination with the printed wiring board.

8.7.3

For components mounted along the edge of a printed wiring board, clearances between uninsulated parts of opposite polarity and uninsulated live parts and a dead conductive part that can be grounded, or a metal part exposed to contact by persons, shall take into consideration the possible movement of the component and the printed wiring board itself. When applying the limits specified in Table 5, the printed wiring board shall be positioned, when movement is possible, in the direction that yields the smallest clearance between the parts in question.

Table 5
Spacing on printed wiring boards and for board mounted components
(See Clauses 8.7.3, 8.8.3, A.10, C.2.4, and C.3.4.2.)

Locations	Maximum voltage between parts, Vrms (Vpeak = 1.4 Vrms) [through air/over surface distance]				
	0 – 50	51 – 150	151 – 300	301 – 450	451 – 600
	Dimensions, mm (in)				
Parts potted or subsequently coated	–/0.18* (–/0.007)	–/0.3* (–/0.012)	–/0.7 (–/0.028)	–/0.8 (–/0.030)	–/0.8 (–/0.030)
For dry and damp locations— Live parts reliably positioned and insulator CTI ≥ 600 (PLC = 0); e.g., lead wires of a transistor or diode to its mounting‡	0.2/0.6 (0.008/0.025)	0.5/0.8 (0.020/0.030)	1.5/1.5 (0.060/ 0.060)	2.25/2.25 (0.090/ 0.090)	3.0/3.0 (0.120/ 0.120)
For dry and damp locations — Live parts reliably positioned and insulator CTI < 600(PLC = 3 or 4); e.g., adjacent foils on printed wiring board or lead wires of a transistor or diode to its mounting§	0.2/1.2 (0.008/0.045)	0.5/1.6 (0.020/0.065)	1.5/3.0 (0.060/ 0.120)	2.25/4.5 (0.090/ 0.175)	3.0/6.1 (0.120/ 0.250)
For wet locations—Live parts reliably positioned and insulator CTI ≥ 600 (PLC = 0); e.g., lead wires of a transistor or diode to its mounting**	0.2/1.5 (0.008/0.060)	0.5/2.0 (0.020/0.080)	1.5/3.7 (0.060/ 0.145)	2.25/5.6 (0.090/ 0.220)	3.0/7.5 (0.120/ 0.300)
For wet locations—Live parts reliably positioned and insulator CTI < 600 (PLC = 3 or 4); e.g., adjacent foils on printed wiring board or lead wires of a transistor or diode to its mounting††	0.2/1.9 (0.008/0.075)	0.5/2.7 (0.020/0.110)	1.5/4.7 (0.060/ 0.185)	2.25/7.1 (0.090/ 0.280)	3.0/9.5 (0.120/ 0.375)
Parts on printed wiring boards that are soldered in place but can move in production prior to soldering to fixed parts or parts on printed wiring board to enclosure, where the enclosure can deflect§§	—	3.0/– (0.120/–)	3.9/– (0.155/–)	4.7/– (0.185/–)	5.6/– (0.220/–)
Live parts and dead conductive parts in a conventional magnetic device where the coil size can vary due to wind or where coil assembly placement can vary in production.	3.2/6.4 (0.125/0.250)	3.2/6.4 (0.125/0.250)	6.4/9.5 (0.250/ 0.375)	6.4/9.5 (0.250/ 0.375)	9.5/9.5 (0.375/ 0.375)

(Continued)

Table 5 (Concluded)

	Maximum voltage between parts, Vrms (V _{peak} = 1.4 Vrms) [through air/over surface distance]				
	0 – 50	51 – 150	151 – 300	301 – 450	451 – 600
Locations	Dimensions, mm (in)				
Field wiring terminals connected to each other and fixed live or dead conductive parts	Not defined	6.4/6.4 (0.250/ 0.250)	6.4/9.5 (0.250/ 0.375)	9.5/9.5 (0.375/ 0.375)	9.5/9.5 (0.375/ 0.375)

*Or as determined by the investigation of the conformal coating, whichever is greater.

‡Other dimensions of over surface distance calculated by the following for voltage less than or equal to 160 V: $D = 0.002V + 0.5$

and the following formula for voltages greater than 160 V:

$$D = 0.005V$$

§Other dimensions of over surface distance calculated by the following for voltages less than or equal to 160 V:

$$D = 0.004V + 1.0$$

and the following formula for voltages greater than 160 V:

$$D = 0.01V$$

**Other dimensions of over surface distance calculated by the following formula for voltage less than or equal to 160 V:

$$D = 0.005V + 1.26$$

and the following formula for voltages greater than 160 V:

$$D = 0.0126V$$

††Other dimensions of over surface distance calculated by the following formula for voltage less than or equal to 160 V:

$$D = 0.0057V + 1.61$$

and the following formula for voltages greater than 160 V:

$$D = 0.016V$$

§§Other dimensions of through air distance calculated by the following formula for voltages between 150 and 1050 V:

$$D = 0.0059V + 2.09$$

Note: D is distance and V is volts.

8.8 Electrical spacings

8.8.1

Minimum spacings for field-wired branch circuit supply terminals, between uninsulated live parts of opposite polarity, between an uninsulated live part and a grounded dead-metal part, and between an uninsulated live part and an accessible dead-metal part shall be in accordance with [Table 6](#).

Table 6
Spacings at field-wiring branch circuit supply terminals
(See [Clause 8.8.1](#).)

Voltage range	Minimum through-air and over-surface spacings between live and dead-metal parts		Minimum spacings between live parts of opposite polarity			
			Through air		Over surface	
V	mm	(in)	mm	(in)	mm	(in)
0 – 125	6.4	(1/4)	3.2	(1/8)	6.4	(1/4)
126 – 300	6.4	(1/4)	6.4	(1/4)	9.5	(3/8)
301 – 600	9.5	(3/8)	9.5	(3/8)	9.5	(3/8)

8.8.2

Minimum spacings for other than field-wired branch circuit supply terminals, between uninsulated live parts of opposite polarity, between an uninsulated live part and a grounded dead-metal part, and between an uninsulated live part and an accessible dead-metal part shall be in accordance with [Table 7](#).

Table 7
Spacings other than field-wiring branch circuit supply terminals

(See [Clauses 8.8.2](#) and [8.11.2.4](#).)

Potential involved, V rms	Minimum spacings					
	Between any uninsulated live part and an uninsulated live part of opposite polarity, uninsulated grounded dead-metal part, or accessible dead-metal part				Between any uninsulated live part and the walls of a metal enclosure	
	Through air		Over surface		Shortest distance	
	mm	(in)	mm	(in)	mm	(in)
0 – 50	1.6	(1/16)*	1.6	(1/16)*	1.6	(1/16)*
51 – 150	3.2	(1/8)*	6.4	(1/4)	6.4	(1/4)
151 – 300	6.4	(1/4)	9.5	(3/8)	12.7	(1/2)
301 – 600	9.5	(3/8)	12.7	(1/2)	12.7	(1/2)

*The spacing between field-wiring terminals of opposite polarity and the spacing between a field-wiring terminal and a grounded dead-metal part shall not be less than 6.4 mm (1/4 in).

8.8.3

Minimum spacings on printed wiring boards and for board-mounted components, between uninsulated live parts of opposite polarity, between an uninsulated live part and a grounded dead-metal part, and between an uninsulated live part and an accessible dead-metal part shall be in accordance with [Table 5](#).

Notes:

- (1) Other than for wiring terminals or spacings to a dead-metal conductive enclosure, spacings may be in accordance with CSA C22.2 No. 0.2. Overvoltage Category II applies to circuits directly connected to the supply source. Printed wiring boards usually have a minimum CTI of 100, unless known to be greater.
- (2) Spacings between uninsulated live parts of different voltage on non-conformal coated printed wiring boards, their connectors, and board-mounted electrical components wired on the load side of line filters or similar voltage peak reduction networks and components, may be 0.58 mm (0.0230 in) plus 0.005 mm (0.0002 in) per V peak.
- (3) Encapsulated parts, inherent spacings of discrete components, along with other conductive parts at their point of connection to these discrete components, and circuits supplied by a Class 2 or LVLE source are to be exempt from spacing requirements.
- (4) Compliance with the dielectric withstand test specified in [Clause 9.4](#) is to be accepted as an alternative means to determine compliance of spacings between any uninsulated live part and any dead metal part.

8.8.4

Enameled and similar film-coated wire shall be identified as an uninsulated live part.

8.8.5

The spacings between output circuitry and dead metal for a ground-referenced circuit shall be based on the maximum open-circuit voltage to ground.

8.8.6

Parts subject to movement relative to other parts shall be positioned in their most severe orientation before spacings are measured, unless reliably held in place.

8.9 Circuit components

8.9.1

A fixed resistor, semiconductor, thermistor, positive temperature coefficient (PTC) or negative temperature coefficient (NTC) resistor, or the like (relied upon to limit the output of a unit or otherwise achieve acceptable performance) shall have permanence and stability that do not decrease its limiting capabilities over time and use. Among the factors considered when evaluating a limiting component are

- (a) the cumulative effects of temperature;
- (b) electrical transients;
- (c) moisture; and
- (d) other environmental conditions.

8.9.2

A component that bridges two circuits that are otherwise required to be isolated from one another shall be one of the following types:

- (a) A Y1 capacitor or two Y2 capacitors in series, complying with the antenna coupling requirements specified in CAN/CSA-E60384-1 and CAN/CSA-E60384-14;
- (b) Two capacitors connected in series. Each capacitor shall comply with the dielectric voltage withstand test specified in [Clause 9.4](#);
- (c) Isolation provided by a transformer that complies with the dielectric voltage withstand test specified in [Clause 9.4](#) and the transformer construction requirements specified in this Standard; or
- (d) Isolation provided by a transformer that complies with the dielectric voltage withstand test specified in [Clause 9.4](#) and the transformer construction requirements for Class 2 specified in CAN/CSA-C22.2 No. 223.

8.10 Protective devices

8.10.1

A protective device used for compliance with this Standard shall meet the requirements applicable to that component. Protective devices include

- (a) eutectic material;
- (b) fuses;
- (c) over temperature and over current protectors;
- (d) thermal protectors; and
- (e) similar devices intended to interrupt or limit the flow of current as a result of overload.

8.10.2

A protective device in a primary circuit shall not be connected in the neutral (grounded) conductor unless the device simultaneously interrupts the grounded and ungrounded supply conductors.

8.10.3

An overcurrent protective device used for construction or performance requirements shall be inaccessible to tampering, or it shall not be interchangeable with a device having a higher current rating.

8.10.4

The fuse type identification and ampere rating shall be marked in accordance with [Clause 10.3.2](#) on or adjacent to a user serviceable fuse or fuse holder.

8.11 Coil insulation

8.11.1 General

8.11.1.1

Coil shall be provided with insulation between the coil and any dead-metal part, and between each adjacent pair of windings. Physical insulation material is not required if the spacings requirements specified in [Clause 8.8](#) are met without any insulation material in place.

Note: Two or more secondary windings may be considered as a single winding and interposing insulation is not required if, when interconnected, the windings comply with the performance requirements for a single winding.

8.11.1.2

Coil insulation shall be either inherently moisture resistant or treated to render it moisture resistant. Film-coated magnet wire is considered to be moisture resistant.

8.11.2 Insulation for transformers

8.11.2.1

Insulation between uninsulated, primary wires of opposite polarity shall be one of the following types:

- (a) Electrical grade paper, waxed or otherwise treated to resist absorption of moisture, with a minimum total thickness of 0.305 mm (0.012 in); or
- (b) Other insulating material with a dielectric breakdown strength of at least 2500 V in the thickness used, as determined by insulating materials tests specified in CAN/CSA-C22.2 No. 223.

8.11.2.2

Insulation between primary and secondary windings shall be one of the following types:

- (a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, with a minimum total thickness of 0.305 mm (0.012 in);
- (b) A molded polymeric material such as a coil form or bobbin with a minimum thickness of 0.644 mm (0.025 in); or
- (c) A material other than a molded polymeric material, and with a dielectric breakdown strength of at least 2500 V in the thickness used, as determined by insulating materials tests specified in CAN/CSA-C22.2 No. 223.

8.11.2.3

Tape used as insulation in lieu of spacings for a flanged bobbin-wound transformer shall provide a continuous 0.8 mm (1/32 in) minimum wide bent up edge against the bobbin flanges.

8.11.2.4

A two-flanged, concentrically-wound transformer shall be subjected to the output loading test requirements specified in [Clause 9.5.3](#). The test shall be continued for 15 days if the transformer has

- (a) the primary winding wound over the secondary winding or the secondary winding wound over the primary winding; and
- (b) the primary winding insulated from the secondary winding by a layer of insulating material other than the material specified in Item (b) of [Clause 8.11.2.1](#).

Note: The [Clause 9.5.3](#) test is not required to be applied for 15 days if

- (a) the primary-to-secondary winding spacings are reliably maintained and comply with [Table 7](#); or
- (b) the requirements in CSA C22.2 No. 0.2 are met for the primary-to-secondary creepage distance, and a comparative tracking index (CTI) rating of 100 for all insulating material is determined.

8.11.2.5

Insulation between the primary winding and the core shall be one of the following types:

- (a) electrical grade paper, waxed or otherwise treated to resist moisture, having a minimum total thickness of 0.305 mm (0.012 in);
- (b) a molded polymeric material, e.g., a coil form or bobbin, having a minimum thickness of 0.644 mm (0.025 in); or
- (c) a material other than a molded polymeric material and with a dielectric breakdown strength of not less than 2500 V in the thickness used, as determined by the insulating materials tests specified in CAN/CSA-C22.2 No. 223.

Note: *Insulation may be reduced or waived between the primary and core when all of the following conditions are met:*

- (a) *The core is comprised of a low electrical conductance material, e.g., ferrite used in switch-mode product.*
- (b) *The core is treated as a live and electrically conductive part when judging insulation and spacings between the core and*
 - (i) *accessible metal parts;*
 - (ii) *the secondary windings; and*
 - (iii) *any other output circuitry.*
- (c) *When applying Item (b), the core is considered to be at the maximum potential of the primary winding.*
- (d) *Insulation between the secondary windings and core are in accordance with Item (c).*

8.11.2.6

Insulation between the primary winding lead connections and a metallic enclosure shall be one of the following types:

- (a) electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, a minimum of 0.305 mm (0.012 in) thick if used in conjunction with an air spacing of at least one-half of what is specified in [Clause 8.8](#);
- (b) electrical grade paper, waxed or otherwise treated to resist the absorption of moisture with a minimum total thickness of 0.71 mm (0.028 in) when the insulation is in contact with the enclosure; or
- (c) insulation with a minimum dielectric breakdown strength of 2500 V in the thickness used for A and 5000 V in the thickness used for B, as determined by the insulating materials tests specified in CAN/CSA-C22.2 No. 223.

8.11.2.7

Insulation, in accordance with [Clause 8.11.2.8](#), shall be provided between a crossover lead and the

- (a) turns of the winding to which it is connected;
- (b) adjacent winding;
- (c) metallic enclosure; and
- (d) core.

8.11.2.8

To meet the requirements of [Clause 8.11.2.7](#), insulation shall be one of the following types:

- (a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, with a minimum total thickness of 0.305 mm (0.012 in); or
- (b) Other insulating material with a minimum dielectric breakdown strength of 2500 V in the thickness used, as determined by the insulating materials tests specified in CAN/CSA-C22.2 No. 223.

Notes:

- (1) *Any insulation type or thickness, or a through air spacing less than what is specified in [Clause 8.8](#), between a crossover lead and the winding to which it is connected may be used if the coil withstands the dielectric voltage withstand test specified in [Clause 9.4](#) with the potential applied between the coil leads and the coil lead cut at the point where it enters the inner layer.*
- (2) *Note (1) does not apply to insulation between a Class 2 secondary crossover lead and*
 - (a) *the secondary winding to which the crossover lead is connected;*
 - (b) *the metallic enclosure; and*
 - (c) *the core.*

8.11.2.9

As per Note (1) of [Clause 8.11.2.8](#), the magnet coil of a molded bobbin transformer having a slot for the crossover or start lead — unspliced at the windings — may be used as crossover lead insulation if

- (a) the slots provide a graduated through air spacing to the winding, increasing to the end turns; and
- (b) the magnet-coil winding withstands the dielectric voltage withstand test specified in [Clause 9.4](#).

8.11.2.10

Insulation between the primary-lead connections and the adjacent winding, and between secondary-lead connections and the primary winding, shall be one of the following types:

- (a) electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, with a minimum total thickness of 0.71 mm (0.028 in); or
- (b) other insulating material with a minimum dielectric breakdown strength of 5000 V in the thickness used, as determined by the insulating materials tests specified in CAN/CSA-C22.2 No. 223.

8.12 Output circuits

8.12.1

When an output is marked or otherwise identified as being Class 2, that output shall comply with the construction, performance, and marking requirements specified in CAN/CSA-C22.2 No. 223.

8.12.2

When an output is marked or otherwise identified as being LVLE, that output shall comply with the construction, performance, and marking requirements specified in [Annex A](#).

8.12.3

When an output is marked or otherwise identified as being SELV, that output shall comply with the construction, performance, and marking requirements specified in CAN/CSA-C22.2 No. 60950.

9 Tests, procedures, and apparatus

9.1 General

9.1.1

A unit intended to be used in an application identified by one of the standards specified in [Clause 1.3.1](#) shall comply with the performance test requirements of that standard. If an end-use application is not specified, or if a safety-related aspect of the unit's performance is not covered by the identified standard, the unit shall comply with the performance requirements specified in [Clause 9](#) of this Standard.

9.1.2

All electrical measurements, unless otherwise specified, shall be conducted

- (a) in a draft-free room;
- (b) at an ambient temperature of 25 ± 5 °C, unless a higher ambient temperature is specified by the manufacturer; and
- (c) with the unit connected to a supply source of nominal frequency that is adjusted to within 5% of the marked rated voltage.

9.2 Input test

9.2.1

The input current (or wattage, if so rated) of an LED array, module, or package shall not exceed 110% of the rating of the unit when operated at rated input voltage.

9.2.2

The input current (or wattage, if so rated) of an LED controller or controlgear shall not exceed 110% of the rating when operated at rated input voltage and supplying rated load.

9.2.3 LED controllers — Input test

9.2.3.1

LED controlgear shall be tested to the input voltage or voltages (for a dynamic range type) as specified in the testing requirements of [Clause 8.1](#). The volts (V), current (I) and watts (W) shall be recorded at the controlgear input and output.

- (a) For all types LED controlgear, open circuit voltage shall be determined with no load connected to the output lead wires or terminal.
- (b) For power limited LED controlgear (e.g., Class 2 or LVLE) under any condition of LED loading — including short-circuit and interconnection of outputs when not prohibited by marking — the maximum output current shall not exceed the values specified in [Tables A.1](#) and [A.2](#).
- (c) For a unit that employs a transformer with no form of protection, measurement shall be made 60 s after the unit is connected to the source of supply.
- (d) For a unit that employs a transformer and an energy limiting impedance or energy limiting circuit (e.g., a resistor, a PTC device, or similar circuitry) required for the purpose, measurement shall be made 5 s after the unit is connected to the source of supply.
- (e) For a unit that employs a transformer and either a thermal cutoff, fuse, or both, all protection shall be defeated during the test and measurement shall be made 60 s after the unit is connected to the source of supply.
- (f) For a unit that employs a transformer and the combination of a limiting impedance or circuit required for the purpose, and a protective device (e.g., a thermal cutoff, fuse, or both), the protective device shall be defeated and measurement shall be made 5 s after the unit is connected to the source of supply.
- (g) For a unit that employs a dc input, and the combination of a limiting impedance or circuit required for the purpose, and a protective device (e.g., a thermal cutoff, fuse, or both), the protective device shall be defeated and measurement shall be made 5 s after the unit is connected to the source of supply.

9.2.3.2

The LED controlgear shall be loaded to at least 85% of the rated power with LED loads.

9.2.3.3

A variable resistor should be added to increase the LED driver load. Consideration should be given to the range of the variable resistor to be able to look for the maximum input current condition. The variable resistor should be capable of handling more than 15% of the load needed to complement the 100% load.

9.2.3.4

The following steps shall be conducted for the input test:

- (a) Monitor the output current and voltage, and slowly change the variable resistor.
- (b) Observe the point where the current (for a current control, or voltage for a voltage control) starts to drop and record when the output drops 3%.

- (c) Move the variable resistor back to the point the output remains at approximately the maximum output $\pm 1\%$.
- (d) Observe the input voltage, adjusting back to the nominal input voltage if necessary.
- (e) Wait 5 min and record the input current.
- (f) Repeat for the minimum and maximum nominal input voltage for a dynamic range type.

9.3 Temperature test

9.3.1

A unit shall be subjected to the temperature test to ensure that the temperatures do not exceed the limits for the components specified in [Table 8](#) during normal operation of the unit. The unit shall be positioned in an alcove or test oven appropriate for the product and maintained in an ambient temperature, as specified in [Table 9](#).

Table 8
Maximum acceptable temperatures
(See [Clauses 9.3.1](#) and [9.3.12.](#))

Materials and components	°C
(a) Components	
(i) Capacitor (other than oil filled)	*
(ii) Fuses	*
(iii) Internal wiring	*
(iv) Potting compound	†
(v) Printed-wiring boards	*
(b) Electrical insulation	
(vi) Class 105 (A) Insulation systems	
Over surface — Thermocouple method	90
Average — Resistance method (fully potted)	105
Average — Resistance method (open core and coil)	95
Class 130 (B) Insulation systems	
Outer surface — Thermocouple method	110
Average — Resistance method	120
Class 155 (F) Insulation systems	
Outer surface — Thermocouple method	135
Average — Resistance method	140
Class 180 (H) Insulation systems	
Outer surface — Thermocouple method	150
Average — Resistance method	165
(vii) Vulcanized fibre employed as electrical insulation for other than coil systems	90
(c) Surfaces	
(viii) A surface upon which the unit is placed or mounted in service	90
(ix) A non-metallic surface of a direct plug-in or through-cord unit	75
(x) Interior surface of field-wiring compartment	See Clause 8.3.4

*There are no temperatures specified; the manufacturer's rated temperature of the material or component is to be used.

†Unless the material is thermal-setting, the maximum potting-compound temperature, when corrected to a 40 °C ambient temperature, is 15 °C less than the softening point of the compound as determined by the Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-ball Apparatus, ASTM E28.

Table 9
Ambient temperature test condition
 (See [Clauses 9.3.1](#) and [A.10.](#))

Device	Test chamber	Ambient temperature
Remote, through-cord, or direct plug-in	Alcove	25 °C
Used within a luminaire	Test oven	40 °C

9.3.2

A unit integral to a luminaire product shall be tested in accordance with the applicable luminaire product standard.

9.3.3

The temperature on any surface inside a terminal or splice compartment, when corrected to 25 °C, shall not be more than 60 °C unless the device is marked maximum 75 °C or maximum 90 °C in accordance with [Clause 10.3.3](#).

9.3.4

A unit for remote applications shall be tested in an ambient air temperature of 25 °C. A temperature test may be performed at any ambient-air temperature within 20 to 30 °C and the variation from 25 °C may be added to or subtracted from the observed temperature readings.

9.3.5

The average of two or more thermocouple readings shall be taken for the air temperature within the test enclosure. Thermocouples as described in [Clause 9.3.17](#) shall be located so that the temperature-sensing portions are 76.2 mm (3 in) from the floor of the test enclosure, and not less than 76.2 mm (3 in) from the nearest wall.

9.3.6

The test shall continue until constant temperatures are obtained. A temperature is considered constant if

- (a) the test has been running for at least 3 h; and
- (b) three successive readings, taken at 15 min intervals, are within 1 °C of one another and are not rising.

9.3.7

For all tests in which a direct plug-in unit is to be energized from a source of supply, the unit shall be operated from an outlet representing the following constructions:

- (a) a duplex receptacle outlet with a nonmetallic faceplate;
- (b) a receptacle mounted on a nonmetallic outlet box, maximum 196 cm³ (12 in³) in volume; and
- (c) an outlet box mounted in a vertical wall section approximately 100 mm (3-1/2 in) thick with plywood or gypsum wallboard surfaces and loosely filled with fibreglass or equivalent thermal insulation.

9.3.8

A unit intended for use inside a luminaire shall be supported in a test oven with its mounting surface down; 76 mm (3 in) above the base of the enclosure in a central position on two 76 mm (3 in) wooden or ceramic cleats. To determine the temperature on the device surface, thermocouples shall be attached to the case in the areas of major heat sources. Temperatures on the device case shall be determined by means of thermocouples, and in the coils by the thermocouple method or rise-of-resistance method specified in CSA C22.2 No. 250.0.

9.3.9

For a unit with potting thermocouples shall be applied to interior components prior to potting.

9.3.10

A thermocouple junction and the adjacent thermocouple lead wire shall be securely held in thermal contact with the surface of the material of which the temperature is being measured. In most cases, adequate thermal contact will be achieved by securely taping or cementing the thermocouple in place. However, if there is a metal surface, brazing or soldering the thermocouple to the metal might be necessary.

9.3.11

It might be necessary to test a modified sample, with additional lead wires that are extended, so that the temperature of each coil of a device may be measured by the resistance method.

9.3.12

The following should be noted for coil insulation temperatures:

- (a) The insulation system temperature (class) is also the internal hot spot temperature limit.
- (b) The average coil temperature, obtained by the change of resistance method, is the average of the entire coil from internal hot spots to the cooler outer-surface. Therefore, the average limit is lower than the internal hot spot, or system limit.
- (c) The thermocouple measurement method gives the temperature of the cooler outer-surface. Therefore, the outer surface limit is lower than the average limit.
- (d) In end-product applications, the thermocouple measurement method is primarily for convenience.
- (e) At a point on the surface of a device where the temperature is affected by another source of heat, the temperature may exceed the value specified in [Table 8](#), provided that the average temperature is not exceeded.

9.3.13

The temperature on a coil can be measured by the thermocouple method or determined by the change-of-resistance method (i.e., comparing the resistance of the winding at the temperature to be measured with its resistance at a known temperature) using the formula specified in [Clause 9.3.14](#).

9.3.14

The temperature of a winding is to be calculated by the following formula:

$$T_H = \frac{R_H}{R_C} [k + A_C] - k + [A_C - A_H]$$

where

T_H = temperature of the coil at the end of the test, °C

R_H = resistance of the coil at the end of the test, Ω

R_C = resistance of the coil at the beginning of the test, Ω

k = a constant which represents the temperature coefficient for the coil (i.e., 234.5 for copper or 225.0 for electrical conductor grade (EC) aluminum)

A_C = ambient temperature of the coil at the beginning of the test when R_C is measured, °C.

Note: A_C is normally 25 °C unless the coil is being tested in an oven at a higher ambient temperature.

A_H = ambient temperature at the end of the test when R_H is measured, °C

9.3.15

Because the winding usually needs to be de-energized before measuring R_H , the value of R_H at shutdown shall be determined by taking several resistance measurements at short intervals, beginning immediately following shutdown. A curve plotted showing the resistance values as a function of time can then be extrapolated to give a value of R_H at shutdown.

9.3.16

If data is collected manually, the values of resistance shall be taken over a 30 s period, at 5 s intervals. The extrapolated value (i.e., to the time of power shutdown) can be determined using a graphical computer spreadsheet application. If a computer spreadsheet is used, the trend-line equation can be determined from the best fit of a linear, polynomial, or exponent regression. If a computer automated (and faster) method is used to collect the data, the values of resistance can be taken as permitted by the method. The extrapolated value (to the time of power shutdown) can be determined by a linear regression.

9.3.17

The junction of the thermocouple shall be secured firmly with the point on the surface that the temperature will be measured on. The thermocouple shall consist of wires not larger than 24 AWG (0.21 mm²) and not smaller than 30 AWG (0.05 mm²). Thermocouples consisting of 30 AWG (0.05 mm²) iron and constantan (Type J) wires, shall be used whenever a referee temperature measurement by thermocouples is necessary. Thermocouples consisting of chromel-alumel (Type K) or copper-constantan (Type T) wires may be used, if it is determined that high-frequency operation will result in eddy current heating of iron and constantan thermocouples.

9.3.18

LED controlgear capable of running in a dynamic voltage range (120 V to 277 V, 347 V to 480 V, etc.) shall be tested at both the minimum and maximum nominal system voltage, and not in all the range.

9.3.19

ALL types of LED controlgear shall be tested with LED loads during the normal temperature test. LED loads may be complemented with variable resistors when the maximum capacity of any LED driver is being determined. LED controlgear shall drive at least a load of 85% LEDs, with the remaining 15% complemented with a variable resistor. The variable resistor shall have a power rate of at least 5 times the power it will be used for.

Note: For example, a 50 W LED driver should be loaded up to at least 42.5 W with LED's. The additional 7.5 W, which complements the 50 W load, should be loaded with a variable resistor with a minimum power capability of 37.5W.

9.4 Dielectric voltage withstand test

9.4.1

The unit shall withstand the test potential specified in [Table 10](#) for 1 min without breakdown using the test equipment specified in [Clause 9.4.2](#), where V is the maximum ac (rms) voltage between the parts under test. If there is excess capacitive leakage current, the capacitors may be removed or the test may be conducted using a dc potential at 1.414 times the ac potential.

Table 10
Dielectric voltage withstand potential
 (See [Clauses 9.4.1](#), [B.1.5](#), and [B.1.6](#).)

Applied potential	Circuit location
2V + 1000	Between primary circuits or secondary circuits operating at greater than 70 V peak and accessible dead conductive parts Between the primary and secondary of a transformer Between PWB traces or other parts operating at different potentials
500 V	Between a secondary circuit operating at no more than 70 V peak and accessible dead conductive parts

9.4.2

The dielectric withstand test equipment shall employ a transformer of at least 500-VA capacity and have a variable output voltage that is sinusoidal or continuous direct current. The applied potential shall be increased from zero at a uniform rate until the required test level is reached. It shall then be held at that level for 1 min.

Note: A 500-VA or larger capacity transformer is not required if the transformer is provided with a voltmeter to measure directly the applied output potential.

9.4.3

If the luminaire employs voltage-limiting clamping devices (MOV) or a line-to-ground filter (capacitors), the luminaire shall be subjected for 1 s, without breakdown, to the following voltages:

- (a) 1.5 times the working voltage; or
- (b) if the voltage-limiting devices or line-to-ground filter operate below 1.5 times the working voltage, the value of the applied voltage shall be 0.9 times the clamping voltage, but not less than that of the working voltage.

Notes:

- (1) Example: $V_{\text{working}} = 120 \text{ V}$,
 (a1) $V_{\text{clamp}} = 200 \text{ V}$, $V_{\text{test}} = 180 \text{ V}$ ($1.5 \times 120 \text{ V} = 180 \text{ V}$)
 (b1) $V_{\text{clamp}} = 150 \text{ V}$, $V_{\text{test}} = 135 \text{ V}$ ($0.9 \times 150 \text{ V} = 135 \text{ V}$)
 (b2) $V_{\text{clamp}} = 130 \text{ V}$, $V_{\text{test}} = 120 \text{ V}$ ($0.9 \times 130 \text{ V} = 117 \text{ V}$, $< V_{\text{working}} = 120 \text{ V}$)
- (2) The test may be conducted using a dc potential at 1.414 times the ac potential.

9.5 Abnormal tests

9.5.1 General

9.5.1.1

Each test in [Clause 9.5](#) shall be conducted on a separate sample unless all parties agree that more than one test be conducted on the same sample.

9.5.1.2

During each test, the grounding means, if provided, shall be connected to ground through a 3 A non-time delay fuse. The unit shall be draped with a double layer of cheesecloth that conforms to the outline of the unit. The unit shall be energized at rated input voltage and frequency. The supply circuit shall be connected in series with a 20 A fuse (time delay type), which will not open in less than 12 s when carrying 40 A.

9.5.1.3

After ultimate results have been obtained for each test, the sample shall be allowed to cool to room temperature. The dielectric voltage withstand test specified in [Clause 9.4](#) shall then be repeated.

9.5.1.4

Risk of fire or electric shock shall be considered to exist if any of the following results occur:

- (a) opening of the ground fuse;
- (b) charring of the cheesecloth;
- (c) emission of flame or molten material from the unit;
- (d) ignition or dripping of a compound from the unit;
- (e) exposure of live parts that pose a risk of electric shock (as per the accessibility requirements specified in [Clause 8.2](#)); or
- (f) breakdown during the subsequent dielectric voltage withstand test.

9.5.2 Component failure test

9.5.2.1

A unit shall not exhibit a risk of fire or electric shock when a simulated short circuit is imposed on electrolytic capacitors or semiconductor devices.

Notes:

- (1) *Circuits in which maximum power levels have been determined to not exceed 50 W need not be evaluated for component failure.*
- (2) *Devices supplied by a Class 2 or LVLE source need not be subject to this test.*

9.5.2.2

Each electrolytic capacitor and semiconductor device shall be short-circuited, one at a time (one fault per test). Each test shall continue until either the unit is no longer operable or until conditions are stable for at least 30 min, as determined by no visual changes or detectable thermal increase.

9.5.3 Output loading test

9.5.3.1

An LED controlgear or controller module shall not exhibit a risk of fire or electric shock when subjected to the tests specified in [Clauses 9.5.3.4](#) to [9.5.3.5](#).

9.5.3.2

During the tests specified in [Clauses 9.5.3.4](#) and [9.5.3.5](#), a circuit protector that is provided as part of the unit shall remain in the circuit. A user-replaceable fuse shall be replaced with the largest fuse the fuseholder will accept. A manually reset protector shall be operated for 10 cycles and the protector contacts shall be operative upon completion of the test. If an automatic reset protector is provided, or the input current is a value other than zero, the test shall be continued for

- (a) 7 h; or
- (b) 15 d if required in accordance with [Clause 8.11.2.4](#).

9.5.3.3

For units with more than one output, the remaining outputs shall be open-circuited or loaded to rated conditions, whichever results in a more severe operating condition.

9.5.3.4

Each output shall be short-circuited in turn. The temperature on the enclosure shall not exceed 90 °C.

Note: A temperature of 150 °C is acceptable if the unit opens permanently within 1 h after initiation of the test.

9.5.3.5

Each output shall be overloaded in turn. Each overload condition shall be conducted with the output loaded to a current (I_L) equal to the rated current (I_R), plus X percent of the difference between the maximum obtainable output current (I_{max}) and the rated output current (I_R). In the tests, the values of X shall be 100, 75, 50, 25, 20, 15, 10, and 5, in that order. If a load current results in continuous operation, further tests need not be conducted. For each test, a variable resistance load shall be adjusted to the required value and readjusted, if necessary, 1 min after application of the source of supply.

Note: The alternate test method specified in [Clause 9.5.4](#) may be used for units that employ a

- (a) thermal link complying with the requirements of CAN/CSA-E60691; or
- (b) fuse complying with the requirements of CAN/CSA-C22.2 No. 248.14.

9.5.4 Output loading — Alternate method

9.5.4.1

With reference to the Note in [Clause 9.5.3.5](#), if the output short circuit test specified in [Clause 9.5.3.4](#) results in opening of a thermal link or fuse, the alternate method specified in [Clause 9.5.4.2](#) or [9.5.4.3](#) may be performed in lieu of the test specified in [Clause 9.5.3.5](#).

9.5.4.2

If short-circuiting causes a thermal link to open, the device shall be shunted and a thermocouple attached to its body. The load current shall be raised slowly until a temperature equal to the rated trip temperature of the device plus 5 °C is reached. Without further readjustment of the load, the unit shall then be operated for the remainder of the specified time (7 h or 15 d, as applicable).

9.5.4.3

If short-circuiting causes a fuse to open, the unit shall be tested with a load current that causes the maximum current to flow into the fused circuit without opening the fuse. The maximum current to be delivered through the fuse shall be determined as follows:

$$I_{FC} = 1.1 (I_{FR}) [1 + n (0.02)]$$

where

I_{FC} = fuse overload current

I_{FR} = fuse current rating

n = an integer that causes the unit to run in a way that I_{FC} can be maintained at its continuous maximum current (7 h or 15 d, as applicable).

9.5.4.4

When this test is conducted, at least two load conditions shall be used:

- (a) one where $I_{FC} (n = c)$ results in continuous operation; and
- (b) one where $I_{FC} (n = c + 1)$ results in the fuse opening prior to the specified time length (7 h or 15 days, as applicable).

Prior to each test, the sample shall be at room temperature.

9.6 50 W point power measurement test

9.6.1

To determine the point beyond which a circuit is unable to deliver more than 50 W of available power, a wattmeter and an adjustable external load resistor shall be arranged as shown in [Figure 3](#). Power limitation may be accomplished by

- (a) the inherent design of the circuit (see [Clause 9.6.2](#));
- (b) the opening of a circuit component (see [Clause 9.6.3](#)); or
- (c) the opening of a protective device (see [Clause 9.6.4](#)).

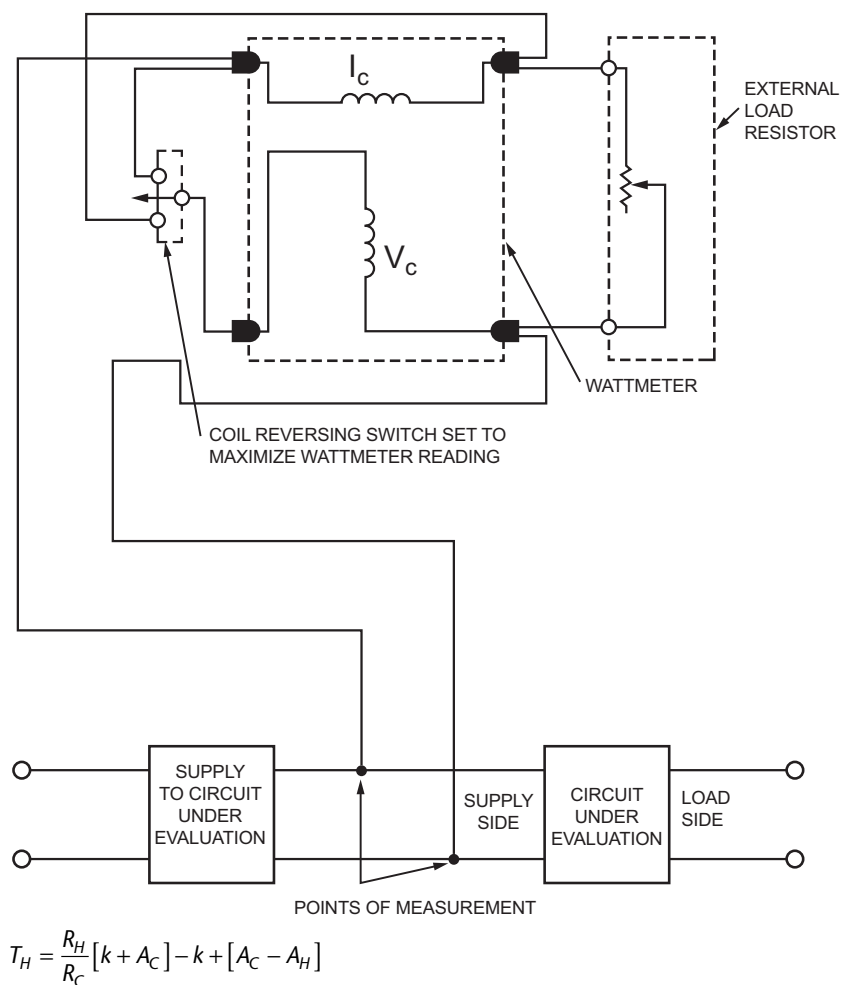


Figure 3
Connection of wattmeter
 (See [Clause 9.6.1.](#))

9.6.2

The external adjustable load resistor shall be set initially for its maximum resistance. The adjustable resistance shall then be reduced gradually to the point of maximum delivery wattage, as indicated by a peak reading on the wattmeter.

9.6.3

For a circuit without a designated current limiting device, a circuit component that opens in less than 1 min at any power delivery level less than 50 W, and that precludes delivery of 50 W for more than one min, shall be considered to effectively limit the circuit output to less than 50 W if the test can be repeated two additional times on new samples with comparable results.

9.6.4

For a circuit with a designated current limiting device, a closed shorting switch shall be connected across the current limiting device and the adjustable resistance shall then be reduced so that a power dissipation of exactly 50 W results, as indicated by the meter. The switch across the current limiting device shall then be opened and the time required for the device to open shall be recorded. A current limiting device that opens the circuit in less than 1 min shall be considered to effectively limit the circuit output to less than 50 W.

9.7 Leakage current measurement test

9.7.1

A cord-connected unit rated for a nominal 250 V or less supply shall be tested in accordance with this Clause. Leakage current shall not be more than

- (a) 0.5 MIU for a two-wire cord- and plug-connected unit;
- (b) 0.5 MIU for a three-wire (including grounding conductor) cord- and plug-connected portable unit; and
- (c) 0.75 MIU for a three-wire (including grounding conductor) cord- and plug-connected stationary or fixed unit.

9.7.2

All accessible conductive parts shall be tested for leakage currents. Leakage currents from these parts shall be measured to the grounded supply conductor individually, as well as together if simultaneously accessible, and from one part to another if they can be easily touched by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that are not considered to pose a risk of electric shock. If all accessible conductive parts are bonded together and connected to the grounding conductor of the power-supply cord, the leakage current can be measured between the grounding conductor of the product and the grounded supply conductor.

9.7.3

If a conductive part other than metal is used for an enclosure or part of an enclosure, leakage current shall be measured using a metal foil with an area of 10×20 cm (4×8 in) in contact with the surface. If the conductive surface has an area less than 10×20 cm (4×8 in), the metal foil shall be the same size as the surface. The metal foil shall conform to the shape of the surface, but shall not remain in place long enough to affect the temperature of the product.

9.7.4

Typical measurement circuits for leakage current with the ground connection open are shown in [Figure 4](#). The measurement instrument is shown in [Figure 5](#). The meter that is used for measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. It need not have all the attributes of the defined instrument. The performance of the instrument over the frequency range 20 Hz to 1 MHz with sinusoidal currents shall be as follows:

- (a) The measured ratio V_1/I_1 with sinusoidal voltages shall be as close as feasible to the ratio V_1/I_1 calculated with the resistance and capacitance values of the measurement instrument shown in [Figure 5](#).
- (b) The measured ratio V_3/I_1 with sinusoidal voltages shall be as close as feasible to the ratio V_3/I_1 calculated with the resistance and capacitance values of the measurement instrument shown in [Figure 5](#). V_3 shall be measured by the meter, M , in the measuring instrument. The reading of M in RMS volts can be converted to MIU by dividing the reading by 500 ohm and then multiplying the quotient by 1 000. The mathematic equivalent is to simply multiply the RMS voltage reading by 2.

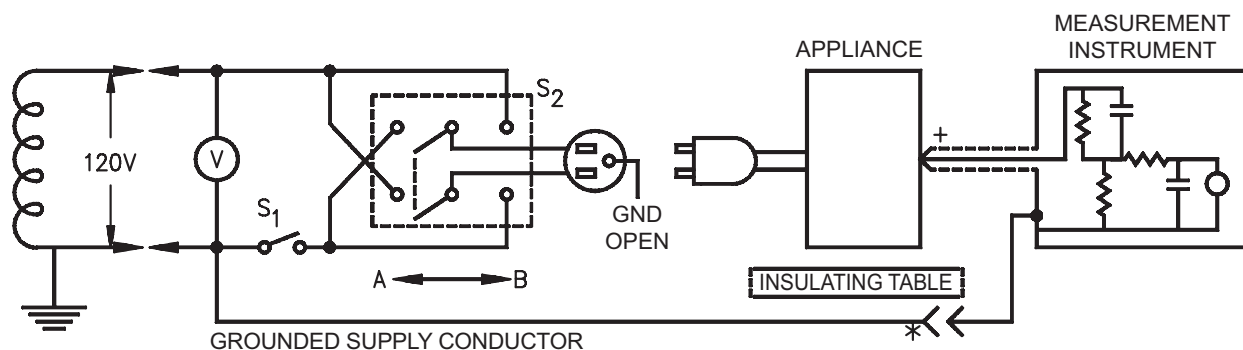


Figure 4
Typical leakage-current measurement circuits
 (See [Clauses 9.7.4, 9.7.6, and A.10.](#))

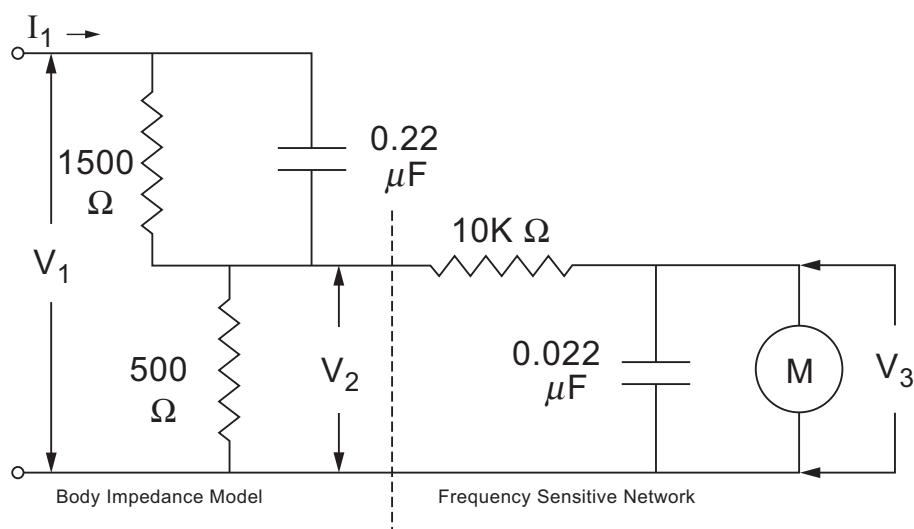


Figure 5
Measurement instrument for reaction (leakage) current
 (See [Clauses 3 and 9.7.4.](#))

9.7.5

Unless the measurement instrument is being used to measure leakage current from one part of a unit to another, it shall be connected between accessible parts and the grounded supply conductor.

9.7.6

The sample unit shall be tested for leakage current without prior energization, except as might occur as part of the production-line testing. The supply voltage shall be adjusted to rated voltage. The test sequence shall be as follows (see the measurement circuit in [Figure 4](#)):

- (a) With switch S1 open, the unit shall be connected to the measurement circuit. Leakage current shall be measured using both switch S2 positions, and with the unit switching devices in their normal operating positions.

- (b) Switch S1 shall then be closed, energizing the unit. Within 5 s, the leakage current shall be measured using both switch S2 positions and with the unit switching devices in their normal operating positions.
- (c) Leakage current shall be monitored until thermal stabilization. Both switch S2 positions shall be used in determining this measurement. Thermal stabilization shall be obtained by operation as specified in the normal temperature test in [Clause 9.3](#).

9.8 Cord strain and push-back relief test

9.8.1

A flexible cord that relies on a strain relief mechanism to limit the stress applied to internal connections shall be subject to a pulling force of 156 N (35 lbf) applied for 1 min in a direction perpendicular to the plane of entrance into the unit.

9.8.2

Following the test specified in [Clause 9.8.1](#), the supply cord shall be gripped 25.4 mm (1 in) from the point where it emerges from the product. When a removable bushing that extends further than 25.4 mm (1 in) is present, it shall be removed prior to the test. When the bushing is an integral part of the cord, the test shall be carried out by holding the bushing. The cord shall be pushed back into the product in 25.4 mm (1 in) increments until the cord buckles, or the force applied exceeds 26.7 N (6 lbf).

9.8.3

A lead wire that leaves the enclosure and relies on a strain relief mechanism to limit the stress applied to internal connections shall be subject to an applied force of 89 N (20 lbf) or four times the weight of the unit, whichever is less, but not less than 22 N (5 lbf), for a period of 1 min.

9.8.4

After completion of the steps specified in [Clauses 9.8.1](#) to [9.8.3](#), the following shall not be exhibited:

- (a) movement of the flexible cord more than 1.6 mm (0.063 in);
- (b) movement of a lead wire that indicates stress was applied to internal connections;
- (c) damage to conductors, connectors, or other components or loosening of connections inside the unit's enclosure; or
- (d) exposure of the supply cord or lead wire to temperatures higher than for which they are rated.

9.9 Security of output terminals

9.9.1

A wire-binding terminal with fewer threads or less thickness than required by [Clause 8.4.2.3.5](#), or that relies on a lockwasher to prevent turning (as per the requirements of [Clause 8.4.2.3.7](#)), shall be subjected to 100 cycles of conductor connection and disconnection, as described in [Clause 9.9.2](#).

9.9.2

The appropriate wires shall be inserted and the tightening torque specified in [Table 11](#) shall be applied to the terminals for 10 s. The terminals shall then be loosened completely. Following 100 cycles, the terminals shall not turn or exhibit any signs of damage.

Table 11
Tightening torque for wire-binding screws
 (See [Clause 9.9.2.](#))

Size of terminal screw		Wire sizes to be tested		Tightening torque	
mm	No.	AWG	(mm ²)	N•m	(lbf•in)
3.5	6	16–22	(1.3–0.32)*	1.4	(12)
4.0	8	14	(2.1)†	1.8	(16)
		16–22	(1.3–0.32)*		
5.0	10	10–14	(5.3–2.1)†	2.3	(20)
		16–22	(1.3–0.32)*		

*Stranded.

†Solid wire.

9.10 Insulation-piercing connection thermal cycling test

9.10.1

Six units shall be assembled with conductors of the size and type for which they are intended. The temperature of the insulation-piercing terminal connections shall be monitored continuously for 7 h while carrying the maximum rated load. The units shall then be subjected to 180 cycles at a rate of 3-1/2 h on and 1/2 h off (the off-cycle time may be extended for the convenience of measurement), while the temperature of the insulation-piercing terminal connections are monitored. After the last cycle, the units shall be energized for a period of 7 h, while temperatures are monitored.

9.10.2

The temperature of the insulation-piercing terminal connections on each LED unit at the end of the test shall not be more than 30 °C higher than the temperatures measured on the same unit after the initial 7 h of operation. The temperature of the insulation-piercing terminal connections shall not exceed 90 °C at any point during the test.

9.11 Adhesive support test

9.11.1

Adhesive used to secure parts together shall have sufficient strength to withstand a pulling force equal to five times the weight of the supported part following the conditioning described in [Clause 9.11.2.](#)

9.11.2

The adhesive secured parts shall be conditioned at 23 °C for 48 h. They shall then be placed in an air-circulating oven at the temperature and time specified in [Table 12.](#) The adhesive rating temperature shall be based on results from the temperature test specified in [Clause 9.3.](#) Conditioning time shall be by mutual agreement of the parties as specified in [Table 12.](#)

Table 12
Adhesive support oven temperature and time
 (See [Clause 9.11.2](#).)

Adhesive rating, °C	Oven temperature, °C			
	300 h (12.5 d)	720 h (30 d)	1000 h (42 d)	1440 h (60 d)
60	125	115	110	100
75	145	135	125	110
90	160	150	140	130
105	180	170	160	145
130	200	190	180	170
155	220	215	205	195
180	245	235	230	220
200	280	265	255	245
220	295	285	275	265
240	N/A	300	290	280

9.11.3

After conditioning, the sample shall be removed from the oven and allowed to cool to room temperature. A separating force shall then be evenly applied for 1 min, perpendicular to the primary axis of the adhesive joint. The parts shall remain secured together.

9.12 Environmental tests

9.12.1 Humidity exposure

9.12.1.1

A unit intended for use in damp locations shall be exposed to moist air with a relative humidity of $88 \pm 2\%$ and a temperature of 32.0 ± 2.0 °C for 168 h.

9.12.1.2

After conditioning, the unit shall be tested for water exposure in accordance with [Clause 9.12.2](#). A unit intended exclusively for damp locations shall be subject to the dielectric voltage withstand test specified in [Clause 9.4](#).

9.12.2 Water exposure

9.12.2.1

A unit intended for use in wet locations shall be subjected to simulated rain produced in accordance with [Clauses 9.12.2.4](#) to [9.12.2.6](#).

9.12.2.2

After exposure, the outer surfaces shall be dried and the dielectric voltage withstand test specified in [Clause 9.4](#) shall be repeated. There shall be no breakdown as a result of the dielectric voltage withstand test.

9.12.2.3

Following the dielectric voltage withstand test specified in [Clause 9.4](#), the unit shall be carefully opened to determine if water has entered. No water shall be in contact with electrical parts, except for those components suitable for exposure to water.

9.12.2.4

During the test the unit shall be positioned in a way that will result in the wetting of the live parts, or in accordance with orientation markings provided for that purpose.

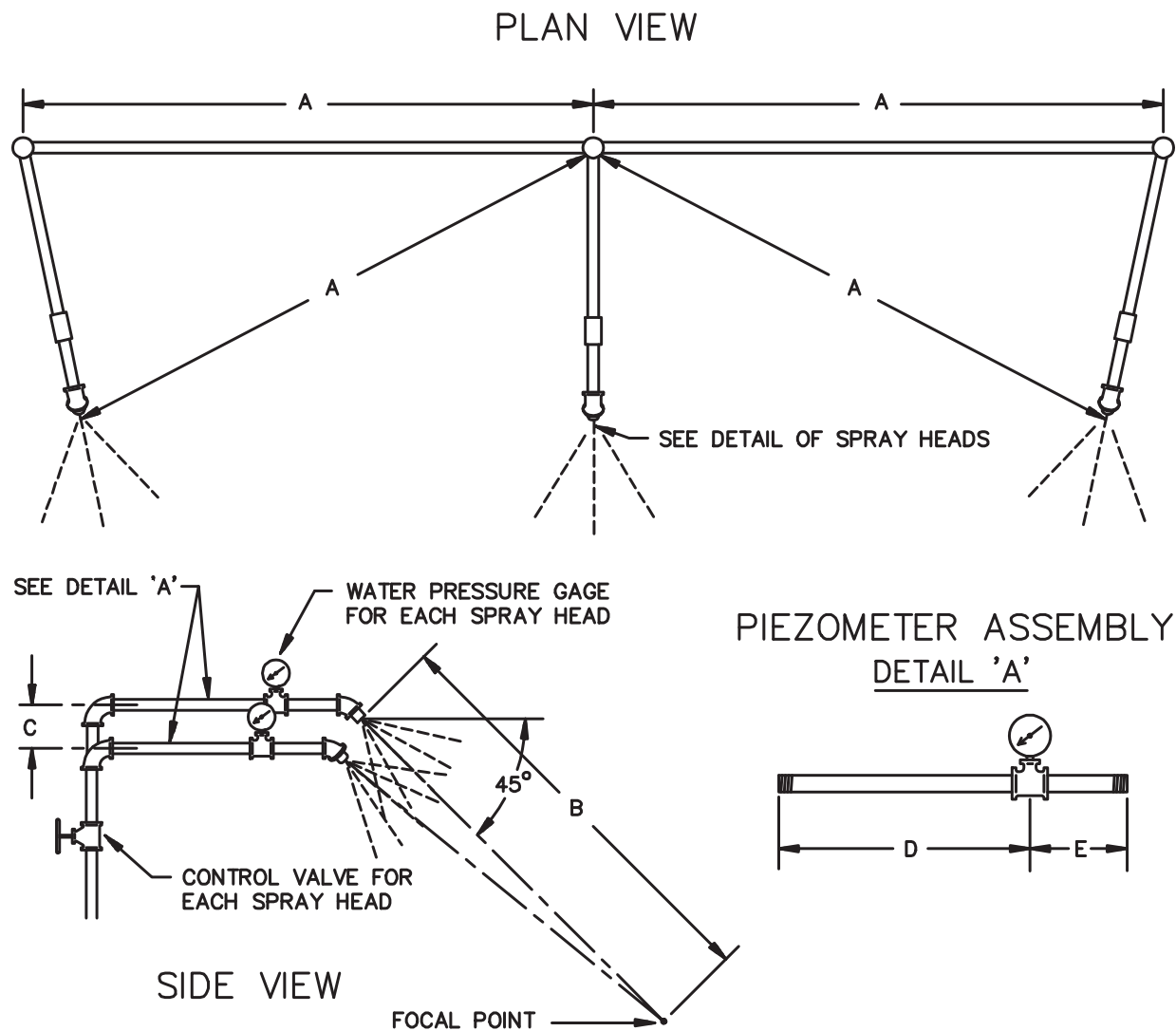
9.12.2.5

The rain test apparatus shall consist of three spray heads mounted in a water supply pipe rack as shown in [Figure 6](#). The spray heads shall be constructed in accordance with [Figure 7](#). The assembly shall be positioned in the focal area of the spray heads so that the greatest quantity of water enters the component. The water pressure shall be maintained at 34.5 kPa (5 psi) at each spray head.

9.12.2.6

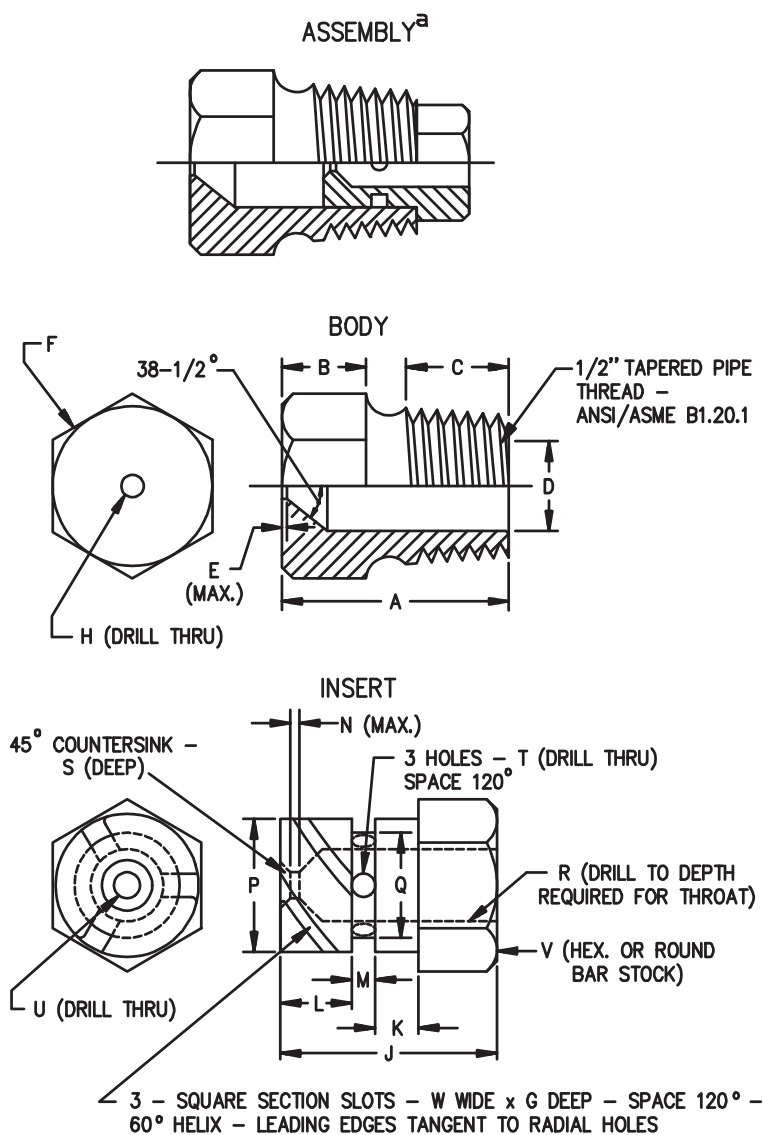
The assembly shall be subjected to water spray for a total of 4 h. During this time the assembly shall be energized and de-energized in the following sequence:

Test duration, h	Test period, h	Operational	Water
0 – 1.0	1.0	On	Off
1.0 – 1.5	0.5	Off	On
1.5 – 3.5	2.0	On	On
3.5 – 4.0	0.5	Off	On



Item	mm	(in)
A	710	(28)
B	1400	(55)
C	55	(2.25)
D	230	(9)
E	75	(3)

Figure 6
Spray head piping
(See [Clause 9.12.2.5.](#))



Item	mm	(in)	Item	mm	(in)
A	31.00	(1.219)	M	2.38	(0.094)
B	11.00	(0.438)	N	0.80	(0.031)
C	14.00	(0.563)	P	14.61 – 14.63	(0.575 – 0.576)
D	14.68 – 14.73	(0.578 – 0.580)	Q	11.51 – 11.53	(0.453 – 0.454)
E	0.40	(0.016)	R	6.35	(0.250)
F	Optional	Optional	S	0.80	(0.031)
G	1.52	(0.060)	T	2.80	(0.110)
H	5.00	(0.196)	U	2.50	(0.980)
J	18.30	(0.719)	V	16.00	(0.625)
K	3.97	(0.156)	W	1.52	(0.060)
L	6.35	(0.250)			

Figure 7
Spray head assembly

(See [Clause 9.12.2.5.](#))

9.13 Mechanical strength tests for metal enclosures

9.13.1

A part of a metal enclosure that is less thick than the minimum thicknesses specified in [Clause 7.2.1](#) shall withstand, in sequence, the tests specified in [Clauses 9.13.2](#) and [9.13.3](#)

- (a) without permanent distortion to the extent that spacings are reduced below the values specified in [Clause 8.8](#);
- (b) without transient distortion that results in contact with live parts other than those connected in a Class 2 or LVLE circuit; and
- (c) without development of openings that expose parts that pose a risk of electric shock or injury. Any openings resulting from the test shall be judged under the requirements for accessibility specified in [Clause 8.2](#).

9.13.2

The enclosure part shall be subjected to a 111 N (25 lbf) force for 1 min. The force shall be applied with a steel hemisphere that is 12.7 mm (1/2 in) in diameter.

9.13.3

The enclosure part shall be subjected to a 6.8 J (5 ft-lb) impact. The impact shall be applied with a smooth, solid, steel sphere 50.8 mm (2 in) in diameter with a 535 g (1.18 lb) mass. The sphere shall fall freely from rest through a vertical distance of 1.29 m (51 in).

10 Markings

10.1 General

10.1.1

A unit intended for an application identified in one of the standards specified in [Clause 1.3.1](#) shall comply with the marking requirements specified in that standard. If an end-use application is not specified, or if construction or performance related marking is not covered, the unit shall comply with the marking requirements specified in this Clause.

10.1.2

Markings shall be legible. The lettering shall be a minimum of 1.6 mm (0.062 in) high and shall use one or more of the following methods:

- (a) lettering on a pressure-sensitive label;
- (b) paint-stenciled lettering;
- (c) ink-stamped machine lettering;
- (d) ink-hand-stamped lettering;
- (e) indelibly printed lettering;
- (f) die-stamped lettering; or
- (g) embossed, molded, or cast lettering, raised or recessed a minimum of 0.25 mm (0.010 in).

10.1.3

Permanent pressure-sensitive labels and nameplates that are secured by an adhesive shall comply with CSA C22.2 No. 0.15. They shall be suitable for the mounting surface material and temperature being used, as well as the environment to which they will be subjected.

10.2 Identification and ratings

10.2.1

All units shall have the following markings:

- (a) company name;
- (b) model designation;
- (c) factory identification or code for any component produced or assembled at more than one factory; and
- (d) date of manufacture.

10.2.2

A power source integrated with a controller or LED array, or both, shall be marked with Items (a) through (c) below. A power source packaged separately from the controller or LED array, or both, shall be marked with Items (a) through (d):

- (a) environmental suitability (i.e., dry, damp, or wet location);
- (b) input voltage;
- (c) input current and power factor, or input wattage; and
- (d) rated output voltage and current (or wattage).

10.2.3

Each power source or controller output intended to supply a Class 2 circuit shall comply with [Clause 8.12](#) and be marked "Class 2."

10.2.4

An LED controller shall be marked with the following:

- (a) environmental suitability (i.e., dry, damp, or wet location);
- (b) input limitations (i.e., Class 2 input only), if applicable;
- (c) input voltage;
- (d) input current or wattage; and
- (e) rated output voltage and current (or wattage).

A wiring diagram and any additional information necessary for proper connection of the LED controller to the intended LED load(s) shall also be provided with a controller. This may be on a separate instruction sheet.

10.2.5

An LED array, module, or package shall be marked with the following:

- (a) environmental suitability (i.e., dry, damp, or wet location);
- (b) input limitations (i.e., Class 2 input only), if applicable;
- (c) input voltage; and
- (d) rated current or wattage.

10.3 Construction-related markings

10.3.1

A unit that employs push-in terminals shall be provided with installation instructions that contain

- (a) information for releasing the wire from the terminal connection;
- (b) the intended wire size(s);
- (c) whether the terminal is intended for both solid and stranded wire or solid wire only;
- (d) the length to strip the insulation from conductors; and
- (e) the terminal relationship to the internal circuitry.

10.3.2

Where a fuse replacement marking is required, it shall be provided on or adjacent to the fuseholder. The marking shall identify the appropriate fuse type and ampere rating.

10.3.3

If the temperature on any surface within a terminal compartment or splice compartment exceeds 60 °C (140°F) during the temperature test specified in [Clause 9.3](#), the unit shall be marked with the following statement or the equivalent, located so that it is readily visible when connections are made:

“For Connections Use Wire Rated for at Least _____,”

The temperature shall be either 75 °C or 90 °C, as determined by the temperature test.

Annex A (normative)

LED controlgear

Note: This Annex is a mandatory part of this Standard.

A.1

A transformer or LED controlgear that complies with any one of the following standards shall be considered to meet the requirements of this Standard:

- (a) CSA C22.2 No. 66.1;
- (b) CSA C22.2 No. 66.2;
- (c) CSA C22.2 No. 66.3; or
- (d) CAN/CSA-C22.2 No. 60065.

A.2

A power supply for use with LED units that complies with any one of the following is considered to meet the intent of the requirements of this Standard:

- (a) CSA 22.2 No. 107.1-01 (R2006);
- (b) CAN/CSA-C22.2 No. 223-M91(R2008); and
- (c) CAN/CSA-C22.2 No. 60950-1.

A.3

A power supply, LED controlgear, or transformer shall be used within its rated input, output, and environmental ratings.

A.4

A power source identified as LVLE controlgear shall have

- (a) no direct electrical connection between input and output (e.g., provided by a transformer);
- (b) an optical isolator; and
- (c) other suitable means.

A limited power source shall have a maximum output voltage of 42.4 V peak ac (30 V rms) or 60 V dc and a maximum output current after 1 min limited to the values specified in [Tables A.1](#) and [A.2](#).

Table A.1
Limits for inherently limited power sources obtained with an isolating transformer or fixed impedance or reliable regulating network
 (See [Clauses 3, 9.2.3.1, A.4 and A.8.](#))

Output voltage* “Uoc” (V)		Output current† “Isc” (A)	Apparent power‡ “S” (VA)
V ac rms	V dc		
≤ 20	≤ 20	≤ 8.0	≤ 5 × Uoc
20 < Uoc ≤ 30	20 < Uoc ≤ 30	≤ 8.0	≤ 100
—	30 < Uoc ≤ 60	≤ 150 / Uoc	≤ 100

*Uoc (V): Output voltage measured in accordance with [Clauses A.6 and A.7](#) with all load circuits disconnected. Voltages are for substantially sinusoidal ac and ripple-free dc. For non-sinusoidal ac and dc with ripple greater than 10% of the peak, the peak voltage shall not exceed 42.4 V.

†Isc (A): Maximum output current with any non-capacitive load, including a short circuit, measured 60 s after application of the load.

‡S(VA): Maximum output VA after 60 s of operation with any non-capacitive load including short circuit.

Table A.2
Limits for not inherently limited power sources obtained by use of a fuse or nonadjustable manually reset circuit protective device rated or set at not more than the value specified in this Table
 (See [Clauses 3, 9.2.3.1, A.4, A.8, and A.9.](#))

Output voltage* “Uoc” (V)		Output current† “Isc” (A)	Apparent power‡ “S” (VA)	Current rating of overcurrent protective device§ (A)
V a.c. rms	V d.c.			
≤ 20	≤ 20	≤ 1,000 / Uoc	≤ 250	≤ 5.0
20 < Uoc ≤ 30	20 < Uoc ≤ 30			≤ 100 / Uoc
—	30 < Uoc ≤ 60			≤ 100 / Uoc

*Uoc (V): Output voltage measured in accordance with [Clauses A.6 and A.7](#) with all load circuits disconnected. Voltages are for substantially sinusoidal ac and ripple-free dc. For non-sinusoidal ac and dc with ripple greater than 10% of the peak, the peak voltage shall not exceed 42.4 V.

†Isc (A): Maximum output current with any non-capacitive load, including a short circuit, measured 60 s after application of the load. Current limiting impedances in the equipment remain in the circuit during measurement, but overcurrent protective devices are bypassed.

‡S (VA): Maximum output VA after 60 s of operation with any non-capacitive load including short circuit. Current limiting impedances in equipment remain in the circuit during measurement, but overcurrent protective devices are bypassed. Initial transients lasting less than 100 ms are permitted to exceed the limit.

Note: Making measurements with overcurrent protective devices is bypassed in order to determine the amount of energy available that might cause overheating during the operating time of the overcurrent protective devices.

§The current ratings for overcurrent protective devices are based on fuses and circuit breakers that break the circuit within 120 s with a current equal to 210% of the current rating specified in this Table.

A.5

Compliance shall be checked through measurement, as per the requirements in [Clauses A.6 to A.9](#) for the determination of low-voltage, limited-energy circuit status.

A.6

When there is more than a single output, all but one shall be open-circuited.

A.7

An open-circuit voltage shall be measured.

A.8

The output to the LVLE shall be connected to a variable resistance load. It shall be adjusted from open to short circuit until a maximum allowable current, as specified in [Tables A.1](#) and [A.2](#), is obtained and maintained for 1 min, at which time a measurement shall be taken. If a specified maximum allowable current cannot be sustained for 1 min under any load condition, the test shall be discontinued.

A.9

Any value may be used for a primary fuse. However, the maximum available output current levels shall be maintained. A fuse replacement marking (voltage and current rating) shall be provided adjacent to any fuse relied upon to limit the output current level, as per the values specified in [Table A.2](#).

A.10

Power supplies that comply with CAN/CSA-C22.2 No. 60950-1, shall fulfill the requirements of this standard for LED controlgear except for the construction, performance, and marking criteria noted below. Based on the specific application (as well as the construction, markings, and prior testing) the requirements of the following Clauses of this Standard shall apply:

- 6.2: Humidity testing for products marked for damp location
- 6.3: Humidity testing for products marked for wet location
- 6.3: Water exposure testing for products marked for wet location
- 7.3.2, [Table 1](#): Polymeric enclosures for products marked for damp or wet locations, footnote ‡ of [Table 1](#)
- 7.3.2, [Table 1](#): Polymeric enclosures for products marked for wet locations, UV Resistance
- 7.4: Enclosure openings
- 7.7.2: Asphalt potting compounds
- 8.4.1.2: Permissible power limited circuit wiring types
- 8.4.2.1.3, [Table 2](#): Unthreaded conduit entry openings — Opening sizes and area of flat surface around the opening
- 8.4.2.1.6, 8.4.2.1.7: Permissible constructions for field wiring openings
- 8.4.2.4: Field wiring terminals — Push-in terminals
- 8.4.3.5: Cord connected devices and power supplies — 18 AWG minimum supply cord gauge
- 8.4.3.6: Cord connected devices and power supplies — Supply cord types for handheld devices
- 8.4.3.6: Cord connected devices and power supplies — Surface marking “W” or “Water Resistant” on supply cords for products marked for Wet locations
- 8.4.4.4.1: Insulation piercing terminals for non Class 2/LVLE circuits
- 8.4.4.4.2: Minimum ratings for flexible cords and wires used with insulation piercing terminals
- 8.4.4.4.3: Testing per [Clauses 8.10](#) and [9.3](#) for non Class 2/LVLE circuits that use insulation piercing connections

- 8.7.3: Printed wiring board over surface distances for products marked for Wet location, [Table 5](#)
- 8.9.2: Resistors that bridge primary — secondary are not allowed.
- 9.3.1 Temperature test, Ambient test temperatures, [Table 9](#)
- 9.7.1(b) and 9.7.1(c), [Figure 4](#) Leakage current — three-wire cord- and plug-connected products
- 10.1.3 Markings — minimum letter height
- 10.2.1 Identification and ratings — Item (d), date of manufacture
- 10.2.2 Identification and ratings — Item (a), environmental suitability
- 10.3 Surface temperature markings for push-in terminals

In addition, the table below provides information regarding defined terms from CAN/CSA-C22.2 No. 60950-1, that are considered equivalent to defined terms in this Standard:

CSA C22.2 No. 250.13 definition	CAN/CSA-C22.2 No. 60950-1 equivalent definition
LVLE – Isolated low voltage limited energy circuit	LPS — Limited power source
Class 2 circuit	Class 2 circuit
Risk of electric shock	SELV — Safety extra low voltage

Annex B (informative)

Manufacturing and production tests

Notes:

- (1) *This Annex is not a mandatory part of this Standard.*
- (2) *The factory test described herein could present an injury hazard to personnel and/or property and should only be performed by persons knowledgeable of such hazards and under conditions designed to minimize the possibility of injury.*

B.1 Dielectric voltage-withstand test

B.1.1

A dielectric voltage-withstand test is to be performed on all luminaires that contain conductors that are

- (a) not visible after assembly; or
- (b) enclosed for a distance more than 38 mm (1.50 in) within
 - (i) a stem, arm, or tubing; or
 - (ii) a conduit that is not listed or certified.

B.1.2

An LED luminaire constructed as described in [Clause B.1.1](#), and provided with a removable cover for access to conductors, are not required to be subjected to the factory dielectric voltage-withstand test. Luminaires are to be fully assembled, with control and protective components in conducting position, switches in the ON position, and fuses in place. Isolated non-current-carrying metal parts or decorative parts not likely to become energized are not required to be in place.

B.1.3

Solid state components not relied upon to reduce the risk of electric shock and that could be damaged by the applied dielectric potential may be disconnected for the test. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid state component damage while retaining the representative dielectric stress on the circuit.

B.1.4

Devices having no accessible metal parts need not be tested.

B.1.5

Each device is to withstand without electrical breakdown, as a routine production-line test, the application of a potential between current-carrying parts of the supply circuit and accessible non-current-carrying metal as indicated in [Table 10](#) or using a dc potential at 1.41 times the ac potential for 1 s.

B.1.6

A device employing a solid-state component that is not relied upon to reduce the risk of electric shock, and that could be damaged by the dielectric potential, may be tested before the component is electrically connected, provided that a random sampling of each day's production is tested at the potential specified in [Table 10](#) or using a dc potential at 1.41 times the ac potential for 1 s.

B.1.7

The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state component damage while retaining representative dielectric stress of the circuit.

B.1.8

Where a solid-state component (LED) cannot be electrically disconnected the insulation resistance between live parts and ground at the completion of a 1 min application of a 500 V dc test voltage should be not less than 2.0 M-ohm.

B.1.9

Where the luminaire employs a voltage-limiting clamping device (MOV) or line-to-ground filter (capacitors), the luminaire is to be subjected for 1 s, without breakdown, to one of following voltages:

- (a) 1.5 times the working voltage; or
- (b) if voltage-limiting devices or line-to-ground filters operate below 1.5 times the working voltage, the value of the applied voltage should be 0.9 times the clamping voltage, but not less than that of the working voltage.

Example: $V_{\text{working}} = 120 \text{ V}$,

(a1) $V_{\text{clamp}} = 200 \text{ V}$, $V_{\text{test}} = 180 \text{ V}$ ($1.5 \times 120 \text{ V} = 180 \text{ V}$)

(b1) $V_{\text{clamp}} = 150 \text{ V}$, $V_{\text{test}} = 135 \text{ V}$ ($0.9 \times 150 \text{ V} = 135 \text{ V}$)

(b2) $V_{\text{clamp}} = 130 \text{ V}$, $V_{\text{test}} = 120 \text{ V}$ ($0.9 \times 130 \text{ V} = 117 \text{ V}$, $< V_{\text{working}} = 120 \text{ V}$)

Note: This test may be conducted using a dc potential at 1.414 times the ac potential.

B.2 Grounding continuity**B.2.1 General****B.2.1.1**

A grounding continuity test should be performed on luminaires with

- (a) non-current-carrying metal parts that might become energized and are accessible during user maintenance; or
- (b) snap-in lampholders with integral grounding means.

B.2.1.2

The frequency of the test should be as follows:

- (a) at least once per production run per design for temperature test-exempt luminaires; and
- (b) at least once per quarter per design for all other luminaires.

B.2.1.3

The grounding continuity test apparatus is to be in accordance with CSA C22.2 No. 250.0.

B.2.1.4

The measured or calculated resistance between the grounding means point of connection and any dead metal part should not exceed 0.10Ω .

B.2.2 Grounding continuity test for unassembled luminaires**B.2.2.1**

A grounding continuity test should be performed on a representative design at least once per quarter.

B.2.2.2

The grounding continuity test for a luminaire that is shipped with the enclosure unassembled, or with snap-in or tab-mounted parts, should be completely assembled in accordance with the assembly instructions. The grounding continuity test should be performed after the applicable parts pull test. The resistance between the two test points should not exceed 0.10 Ω .

B.2.2.3

The grounding continuity test apparatus should consist of an indicating instrument and an ac or dc power supply that is approximately 12 V and provides a current of 25 A through the bonding means being evaluated.

Alternatively, the grounding continuity test apparatus may be an ohmmeter or similar indicating instrument capable of measuring 0.10 Ω .

B.3 Glass support

One sample of each luminaire style that employs a glass diffuser supported by friction alone should be tested at least once per quarter to determine compliance as per the test specified in this Clause.

The test should be conducted as follows:

- (a) weigh the diffuser;
- (b) pour a granular material, such as sand, equal to four times the weight of the diffuser into the diffuser, distributing it evenly; and
- (c) mount the diffuser as intended.

The diffuser should stay in place for 1 min.

B.4 Strain relief**B.4.1**

One sample of each luminaire design with a power supply cord should be tested at least once per quarter to determine compliance with the strain relief test. The test should be conducted as follows:

- (a) A pull force of 156 N (35 lb) should be applied for 1 min to the flexible cord in a direction perpendicular to the plane of the entrance into the luminaire.
- (b) Test results should be acceptable if there is no
 - (i) movement of the flexible cord of more than 1.6 mm (0.063 in); and
 - (ii) breaking of the conductor or loosening of the wiring connections inside the enclosure of the luminaire.

B.4.2

One sample of each luminaire design with a lamp-supported lampholder should be tested at least once per quarter to determine compliance with the strain relief test. The test should be conducted as follows:

- (a) A pull force of 89 N (20 lb) should be applied for 1 min to the conductor in a direction perpendicular to the plane of the entrance to the conductor connection.
- (b) There should be no breaking of the conductor or loosening of the conductor connections.

B.5 Polarity**B.5.1**

One sample of each luminaire design required to comply with the identification and polarity requirements (see * below) should be tested at least once per quarter to determine compliance with the polarity test specified in CSA C22.2 No. 250.0 unless the polarity can be verified visually.

**Identification and polarity.*

B.5.2

Continuity should be verified between the point where the identified (neutral) branch circuit conductor is intended to be connected to the luminaire and the lampholder screwshell, using an indicating device such as an ohmmeter or other continuity testing device.

B.5.3

A conductor terminal intended for the connection of the neutral conductor of the branch circuit should be substantially white in colour or should be marked neutral adjacent to the terminal:

“N or NEUTRAL or W or WHITE”

B.5.4

The insulation on a conductor intended for connection to the neutral conductor of the branch circuit should be identified as follows:

- (a) white or natural grey colour;
- (b) any colour except green, with a continuous white tracer throughout its length;
- (c) white paint, tape, ink, or a permanent tag at the point where it is connected to the branch circuit; or
- (d) one or more raised longitudinal ridges, if a parallel conductor flexible cord.

B.5.5

The identified terminal of a wiring device should be connected to the neutral conductor of the branch circuit.

B.5.6

A cord-and-plug-connected luminaire equipped with a polarized two-pole, two-wire parallel blade attachment plug should be marked for proper polarity:

“TO PREVENT ELECTRIC SHOCK, MATCH WIDE BLADE OF PLUG TO WIDE SLOT”

B.6 Test records

Test records should be retained for a period of at least six months, and should include test quantity, test dates, catalog or model numbers, test results, and disposition of any non-complying products.

Annex C (normative)

Printed circuit boards (PCB)

Note: This Annex is a mandatory part of this Standard.

C.1 Special terminology

The following definitions shall apply in this Annex:

Insulation, basic — insulation used to provide basic protection against electric shock.

Insulation, double — insulation comprising both basic insulation and supplementary insulation.

Insulation, functional — insulation that is needed only for the correct operation of the equipment.

Insulation, reinforced — a single insulation system that provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this Standard.

Insulation, supplementary — independent insulation applied in addition to basic insulation in order to reduce the risk of electric shock in the event of a failure of the basic insulation.

C.2 General

C.2.1

A printed circuit board that is coated with a conformal coating or other coating shall be capable of withstanding the printed circuit board coatings test of [Clause C.3](#). The coating shall be applied to the printed circuit board before installation of electrical components.

C.2.2

Printed circuit boards, conformal coating, and components shall have a flammability classification of at least V-2. PCB having an HB flammability rating is considered to have an equivalent of a V-2 rating when it complies with the needle flame test specified in CAN/CSA-C22.2 No. 0.17.

C.2.3

Components, such as IC packages, transistors, opto-isolators, and capacitors shall be exempt from the flammability classification V-2 requirement specified in [Clause C.2.2](#) if they are mounted on material having a flammability classification of at least V-1.

C.2.4

Spacings between uninsulated live parts of a circuit containing a solid-state component, such as a rectifier, resistor, capacitor, or transistor shall

- (a) be not less than the values shown in [Table 5](#);
- (b) withstand the insulation resistance test specified in [Clause C.3.3](#); or
- (c) withstand the fault conditions test specified in [Clause C.3.4](#).

C.3 Printed circuit board coatings

C.3.1 Dielectric strength

C.3.1.1

A specimen shall be conditioned by flexing it four times so that the midpoint of the board is displaced from the line joining the two shortest edges of the board a distance equal to 5% of the length of the printed circuit board, to simulate conditions that can be expected under normal handling.

C.3.1.2

The following test voltages shall be applied for 1 min, without breakdown, between adjacent printed circuit conductors where the reduced spacings exist:

- (a) 500 V for a circuit operating at 50 V or less; and
- (b) 1000 V plus twice the working voltage for a circuit operating at more than 50 V.

C.3.1.3

The same specimen shall be conditioned by maintaining it at 90 ± 1 °C for 96 h, and then shall be subjected to the test specified in [Clause C.3.1.2](#).

C.3.1.4

The same specimen shall be conditioned at 23 ± 1 °C and $96 \pm 2\%$ relative humidity for 96 h and then shall be subjected to the test specified in [Clause C.3.1.2](#).

C.3.2 Adhesion

C.3.2.1

The same specimen used for the dielectric strength test shall be investigated for adhesion of the coating to the board by pressing a strip of pressure-sensitive celluloid tape 12.7 mm (0.5 in) wide and 50 mm (2 in) long firmly onto the surface of a conductor pattern, eliminating all air bubbles, and then removing it by manually gripping one end and rapidly pulling it off at an angle of approximately 90°. There shall be no evidence of removal of the protective coating or the conductor pattern as shown by the pattern particles adhering to the tape. If slivers of metal adhere to the tape, it could be evidence of overheating and unacceptable bond strength. The tape used for this test shall have an adhesion of 400 ± 60 N/m (27 ± 4 lb/ft), as determined by ASTM D1000.

C.3.2.2

Using a specimen as described in [Clause C.3.2.1](#) and the apparatus specified in [Clause C.3.2.5](#), scratches shall be made across five pairs of conducting parts and the intervening separations at points where the separations will be subjected to the maximum potential gradient during the tests.

C.3.2.3

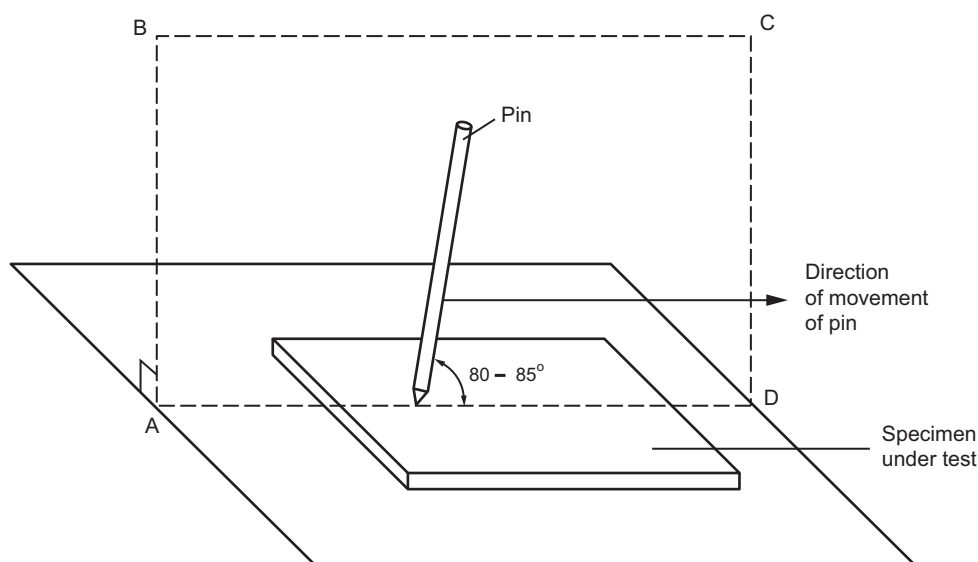
Scratches shall be made by drawing the pin along the surface in a plane perpendicular to the conductor edges at a speed of 20 ± 5 mm/s (0.8 ± 0.2 in/s), as shown in [Figure C.1](#). The pin shall be loaded so that the force exerted along its axis is 10 ± 0.5 N (2.25 ± 0.1 lb) from the edge of the specimen.

C.3.2.4

After this test, the coating layer shall neither have loosened nor have been pierced, and the specimen shall withstand a dielectric strength test between conductors, as specified in [Clause C.3.1](#).

C.3.2.5

The test apparatus shall be as shown in [Figure C.1](#). The pin shall be made of hardened steel. The end of the pin shall have the form of a cone with a top angle of 40° . Its tip shall be rounded and polished, with a radius of 0.25 ± 0.02 mm (0.010 ± 0.001 in).



Note: The pin is in the plane ABCD, which is perpendicular to the specimen under test.

Figure C.1
Abrasion resistance test apparatus for PCB conformal coatings
(See [Clauses C.3.2.3](#) and [C.3.2.5](#).)

C.3.3 Insulation resistance test voltage

Functional, basic, supplementary, double, and reinforced insulation shall withstand the test voltages shown in [Table C.1](#), in accordance with the dielectric voltage-withstand test specified in [Clause C.3.1](#).

Table C.1
Insulation resistance test voltages
 (See [Clause C.3.3.](#))

Printed circuit boards with an earth ground conductive part as the protective means				
Maximum operating voltage (MOV)	0–50	51–130	131–250	251–1000
Basic insulation between the supply conductors and grounded metal parts	500	1000	1500	Twice MOV + 1000
Basic insulation between the supply-circuit conductors and the isolated secondary circuits	500	1000	1500	Twice MOV + 1000
Basic insulation between the isolated secondary circuits and grounded metal parts	500	500	500	500
Functional insulation between the isolated secondary circuits	500	500	500	500
Printed circuit boards provided with double or reinforced insulation				
Maximum operating voltage (MOV)	0–50	51–130	131–250	251–1000
Basic insulation between the supply-circuit conductors and the isolated circuits	500	2500	3000	3000
Basic insulation between the supply-circuit conductors and internal intermediate metal parts	500	1000	1500	Twice MOV + 1000
Supplementary insulation	500	1500	1500	Twice MOV + 1000
Functional insulation between the isolated secondary circuits	500	500	500	500
Double or reinforced insulation between uninsulated live parts of the supply circuit and ungrounded accessible enclosure surfaces	500	2500	3000	3000

C.3.4 Fault conditions

C.3.4.1

The printed circuit board with components shall be subjected to the fault conditions test of [Clause C.3.4.2](#)

C.3.4.2

Each of the fault conditions in Items (a) and (b), as well as any other associated fault conditions that can arise as logical consequences, shall be applied in turn. Only one component at a time shall be subjected to any one fault condition:

- (a) single-fault conditions representing the failure of components such as, but not limited to, semiconductor devices, capacitors, resistors, inductors, transformers, and protective devices. The failure mode shall be chosen to represent the manner in which the component is known to fail; and
- (b) opening or bridging points in the circuit where the spacing between the uninsulated live parts of a rectifier, resistor, capacitor, transistor, or other solid-state device is less than the values shown in [Table 5](#), and where such a fault condition can impair safety.

Annex D (informative)

Standards for components that are used in products covered by this Standard

Note: *This Annex is not a mandatory part of this Standard.*

D.1

Standards under which components of the products covered by this Standard are evaluated include the following:

CSA (Canadian Standards Association)

C22.2 No. 0-10

General Requirements — Canadian Electrical Code, Part II (Appendix B)

C22.2 No. 0.2-93 (R2008)

Insulation coordination

C22.2 No. 0.15-01 (R2006)

Adhesive labels

CAN/CSA-C22.2 No. 0.17-00 (R2009)

Evaluation of properties of polymeric materials

C22.2 No. 21-95

Cord sets and power supply cords

C22.2 No. 24-93

Temperature-indicating and -regulating equipment

C22.2 No. 35-09

Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable

C22.2 No. 42-10

General use receptacles, attachment plugs, and similar wiring devices

C22.2 No. 43-08

Lampholders

C22.2 No. 49-10

Flexible cords and cables

C22.2 No. 55-M1986 (R2008)

Special use switches

CAN/CSA-C22.2 No. 65-03 (R2008)

Wire connectors

C22.2 No. 66.1-06 (2011)

Low voltage transformers — Part 1: General requirements

C22.2 No. 66.2-06 (R2011)

Low voltage transformers — Part 2: General purpose transformers

C22.2 No. 66.3-06 (R2011)

Low voltage transformers — Part 3: Class 2 and Class 3 transformers

CAN/CSA-C22.2 No. 74-96 (R2010)

Equipment for use with electric discharge lamps

C22.2 No. 75-08

Thermoplastic-insulated wires and cables

C22.2 No. 107.1-01 (R2011)

General use power supplies

C22.2 No. 127-09

Equipment and lead wires

C22.2 No. 158-10

Terminal blocks

C22.2 No. 182.3-M1987 (R2009)

Special use attachment plugs, receptacles, and connectors

C22.2 No. 190-M1985 (R2009)

Capacitors for power factor correction

C22.2 No. 198.1-06 (R2010)

Extruded insulating tubing

C22.2 No. 205-M1983 (R2009)

Signal equipment

C22.2 No. 210-11

Appliance wiring material products

CAN/CSA-C22.2 No. 223-M91 (R2008)

Power supplies with extra-low-voltage Class 2 outputs

C22.2 No. 235-04 (R2009)

Supplementary protectors

CAN/CSA-C22.2 No. 248.14-00 (R2010)

Low-voltage fuses — Part 14: Supplemental fuses

CAN/CSA-C22.2 No. 4248.1-07

Fuseholders — Part 1: General requirements

CAN/CSA-C22.2 No. 4248.4-07

Fuseholders — Part 4: Class CC

CAN/CSA-C22.2 No. 4248.5-07

Fuseholders — Part 5: Class G

CAN/CSA-C22.2 No. 4248.6-07
Fuseholders — Part 6: Class H

CAN/CSA-C22.2 No. 4248.8-07
Fuseholders — Part 8: Class J

CAN/CSA-C22.2 No. 4248.9-07
Fuseholders — Part 9: Class K

CAN/CSA-C22.2 No. 4248.11-07
Fuseholders — Part 11: Type C (Edison Base) and Type S pug fuse

CAN/CSA-C22.2 No. 4248.12-07
Fuseholders — Part 12: Class R

CAN/CSA-C22.2 No. 4248.15-07
Fuseholders — Part 15: Class T

CAN/CSA-C22.2 No. 60065-03 (R2007)
Audio, video and similar electronic apparatus — Safety requirements

CAN/CSA-C22.2 No. 60950-1-07
Information technology equipment — Safety — Part 1: General requirements

CAN/CSA-C22.2 No. 61058-1-09
Switches for appliances — Part 1: General requirements

CAN/CSA-E60384-1-03 (R2007)
Fixed capacitors for use in electronic equipment — Part 1: Generic specification

CAN/CSA-E60384-14-09
Fixed capacitors for use in electronic equipment — Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

CAN/CSA-E60691-08
Thermal-links — Requirements and application guide

E60730-1-02 (R2007)
Automatic electrical controls for household and similar use — Part 1: General requirements

IEC (International Electrotechnical Commission)

60730-1:2010
Automatic electrical controls for household and similar use — Part 1: General requirements (See Clauses 15, 17, J15, and J17.)

60707:1999
Flammability of solid non-metallic materials when exposed to flame sources (where power dissipation exceeds 15 W)

Annex E (informative)

Principles of electrical safety

Note: *This Annex is not a mandatory part of this Standard.*

E.1 General principles of safety

It is essential that designers understand the underlying principles of safety requirements so they are able to engineer safe equipment.

These principles are not an alternative to the detailed requirements of this Standard, but are intended to provide designers with an appreciation of the basis of these requirements.

There are two types of persons whose safety needs to be considered: users (or operators) and service personnel.

“User” is the term applied to all persons other than service personnel. Requirements for protection should assume that users are not trained to identify hazards, but will not intentionally create a hazardous situation. In general, users should not have access to hazardous parts, and to this end, such parts should only be in service access areas or in equipment located in restricted access locations.

Service personnel are expected to use their training and skill to avoid possible injury to themselves and others due to obvious hazards which exist in service access areas of the equipment or on equipment located in restricted access locations. However, service personnel should be protected against unexpected hazards. This can be done by, for example, locating parts that need to be accessible for servicing away from electrical and mechanical hazards, providing shields to avoid accidental contact with hazardous parts, and providing labels or instructions to warn personnel about any residual risk.

Information about potential hazards can be marked on the equipment or provided with the equipment, depending on the likelihood and severity of injury, or made available for service personnel. In general, users are not to be exposed to hazards likely to cause injury, and information provided for users should primarily aim at avoiding misuse and situations likely to create hazards, such as connection to the wrong power source and replacement of fuses by incorrect types.

E.2 Hazards — Internal to the equipment

Equipment needs to be designed and constructed so that, under all conditions of normal use and under likely abnormal use or single fault conditions, protection is provided to reduce the risk of personal injury from electric shock and other hazards, and against the spread of fire originating in the equipment.

Due to a sensitive thermal management of LED lighting products, special consideration needs to be given to determination of whether the LED luminaire is evaluated with power supply having constant current or constant voltage, or with power supply having non-regulated output.

In addition, for LED luminaires and electronic LED controlgear, the software safety evaluation might need to be conducted where any safety features (e.g., output voltage and current limitations, short circuit, overloading, temperature limitations, etc.) are controlled and regulated by software, using CSA C22.2 No. 0.8 for evaluation. See [Clause 5](#) of this Standard for more details.

Application of a safety standard is intended to reduce the likelihood of injury or damage mainly due to the following:

- (a) Electric shock (see [Clause E.2.1](#));
- (b) Fire (see [Clause E.2.2](#)); and
- (c) Energy (see [Clause E.2.3](#)).

However, other hazards, such as mechanical hazards, heat related hazards, photo-biological hazard (including UV radiation), or emission of hazardous materials such as ozone, need to be considered.

LED lighting equipment is unique in approach to the electric shock and fire hazard, where use of power supplies with isolated secondary (output) and/or with limited power has substantial impact on safety requirements, simplifying evaluation and testing.

E.2.1 Electric shock hazard — Internal to the equipment

Steady state voltages up to 42.4 V peak, or 60 V dc, are not generally regarded as hazardous under dry conditions for an area of contact equivalent to a human hand. Bare parts which have to be touched or handled should be at earth potential or properly insulated. It is normal to provide two levels of protection for USERS to prevent electric shock. Therefore, the operation of equipment under normal conditions and after a single fault, including any consequential faults, should not create a shock hazard. In addition, a touch current should be limited to a specified value. (See Risk of electric shock, [Clause 3](#).)

For the purpose of this Standard, live parts from either SELV, LVLE, or Class 2 circuits are not considered to present a risk of electric shock, and therefore no electrical enclosure is needed. Notwithstanding, live parts coming from SELV circuits need to comply with a maximum touch current as per [Clause 3](#) after single abnormal tests.

Different values are applied for accessible live parts within the lighting equipment and outside of lighting equipment. The values for electric shock within the lighting equipment are specified by this Standard, while the user assessable values outside the lighting equipment are limited to 30 V rms or 42.24 V peak or dc as specified by the *Canadian Electrical Code, Part I*, Rule 16-222(1).

E.2.2 Fire hazard — Internal to the equipment

Hazards can result from excessive temperatures (either under normal operating conditions or due to overload), component failure, abnormal operation, insulation breakdown, or loose connections. Fires originating within the equipment should not spread beyond the immediate vicinity of the source of the fire, nor cause damage to the surroundings of the equipment.

Examples of measures to reduce such hazards include

- (a) providing overcurrent protection or using LVLE or Class 2 power supplies;
- (b) selection of parts, components and consumable materials to avoid high temperature
- (c) which might cause ignition; and
- (d) using suitable materials for enclosures or barriers.

For the purpose of this Standard, the lighting equipment or its parts supplied from either SELV, LVLE or Class 2 circuits are not considered to present risk of fire hazard, and therefore no fire enclosure is needed. Notwithstanding, the lighting equipment or its parts supplied from SELV circuits need to have less than 240 VA and comply with abnormal tests without presenting any sign of fire hazard.

E.2.3 Energy related hazard — Internal to the equipment

SELV circuits accessible to the user, but not exiting the enclosure, need to be free from shock and energy hazard. For these SELV circuits, other than LVLE or Class 2, no electrical enclosure is needed when the following conditions are met:

- (a) Operator accessible circuits inside the equipment may be accessible, provided that there is no energy hazard (i.e., the power output is limited to less than 240 VA).
- (b) Accessibility is determined by trying to short two points between which power exceeds 240 VA. (See Finger Probe, [Figure 1](#)); and
- (c) For a service (trained) person, only accidental contact with parts exceeding 240 VA are to be prevented.

E.3 Canadian Electrical Code, Part I, Class 2 circuits

Rule 16-200 of the *Canadian Electrical Code, Part I* describes requirements for Class 2 circuits that are, depending on the voltage, divided into four categories:

- (a) 0-20 V;
- (b) 20-30 V;
- (c) 30-60 V; and
- (d) 60-150 V rms.

However, for the purpose of this Standard, we recognize extra low voltage (ELV) Class 2 circuits up to 30 V rms (42.4 V peak or dc) and Class 2 circuits above ELV level, up to 150 V rms. All Class 2 circuits operate at very limited power levels and, since the hazard is reduced by the lower power availability, a less

onerous set of requirements can be used for those circuits. Class 2 circuits are designed to limit the continuous available power to 100 VA. Therefore, transformers supplying Class 2 circuits need to have rated (marked) output not exceeding 100 VA. A Class 2 power supply needs to have its rating and "Class 2" markings. LVLE power supply needs to have its rating and be marked, "LVLE and suitable for use in Class 2 circuits".

Per Rule 16-222(1) of the *Canadian Electrical Code, Part I*, ELV Class 2 circuits may be accessible to the operator, while Class 2 circuits (e.g., 60 V dc) are not to be accessible for touch. Therefore the voltage on exposed terminal outside the lighting products cannot exceed 42.4 V peak or dc. An output from devices complying with Class 2, LVLE and SELV requirements are deemed in compliance with Rule 16-222(1).

E.4 Class 2 circuits

E.4.1

When Class 2 circuits are employed inside a luminaire the following shall apply:

- (a) Electrical spacings at field wiring terminals and printed circuit boards are not applicable and where bridging of the traces will not cause a fire hazard.
- (b) Internal wiring of Class 2 circuits is not required to be a certified type, but must have adequate temperature rating and voltage for the application or meet reduced requirements of the end product Standard.
- (c) An enclosure is not required or, if supplied, meets a reduced flammability requirement.
- (d) A circuit inside the enclosure is not necessarily required to be a Class 2, however, it must be free from shock and energy hazard.

E.4.2

When Class 2 circuits are employed for field wiring of a luminaire the following shall apply:

- (a) Comply with Section 16 of the *Canadian Electrical Code, Part I*.
- (b) Be provided with a means for accommodating Class 2 wiring or be provided with a means to accommodate an approved type raceway.
- (c) Be provided with reduced construction requirements as specified in an applicable Part II Standard.

For the purpose of this Standard, power supplies that comply with the requirements for Class 2 or LVLE (LPS) power sources are considered acceptable and in compliance with Rule 16-200 of Section 16 of the *Canadian Electrical Code, Part I*.

E.4.3

A circuit need not be Class 2 if it is accessible but does not exit the enclosure. However, it must be ELV and free from shock and energy hazard.

E.4.4

A circuit needs to be a Class 2 circuit in the following circumstances:

- (a) A circuit needs to be Class 2 if the Class 2 wiring methods specified in the *Canadian Electrical Code, Part I* are used.
- (b) A circuit exiting the enclosure of a unit of equipment needs to be ELV Class 2 if no suitable wiring or cabling is provided.
- (c) A circuit exiting the enclosure needs to be ELV Class 2 (free from shock hazard and energy hazard) if accessible.
- (d) A circuit needs to be ELV Class 2 if advantage is to be taken of reduced construction requirements specified in a *Canadian Electrical Code, Part II* Standard.

For the purpose of this Standard, power supplies that comply with criteria for Class-2 or LVLE power supplies are considered suitable for use with Class 2 circuits, as per the *Canadian Electrical Code, Part I*, Section 16-200.

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