UL 2108

STANDARD FOR SAFETY

Low Voltage Lighting Systems

UL Standard for Safety for Low Voltage Lighting Systems, UL 2108

Second Edition, Dated December 7, 2015

Summary of Topics

These revisions to ANSI/UL 2108 dated April 18, 2023 include the following changes in requirements:

- ***Scope simplification; 1.1***
- ***Scope exclusions; 1.5***
- ***Definition Removals; 3.13, 3.14, 3.14.1, 3.21 and 3.23***
- ***Permitted openings in recessed housings; 11.9***
- ***Protective devices and the Maximum Output Test; 19.1 and 33.2.2***
- ***Power unit temperature test; 34.2.3, 48.2.8 and 48.2.8A***
- ***Overload Test; 36.2 and Figure 36.1***
- ***Removal of surge protection devices for dielectric withstand test; 37.1 and Appendix A***
- ***Reduced the marking minimum letter height; 48.1.3, 48.2.7, 48.4.3, 48.5.2, 67.1.3, 67.1.5, 67.1.6 and 83.1***
- ***Marking type options; Table 48.1, 48.1.10 and 48.1.11***
- ***Class 2 luminaires with signal inputs; 51.1***
- ***Clarification of class 2 wet location compliance; 51.3 and 73.7***
- ***Class 2 device housings; 3.6A, Section 53, 62.1, 62.4 and 66.1***
- ***Separable mounting means for class 2 luminaires; 54.1 and 68.5***
- ***Grounding permitted but not required for class 2 luminaires; 59.4***
- ***Editorial Corrections; Section 6, 9.1, 45.4, Table 51.1 and B2.1.8***

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 3, 2023.

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UL 2108

Standard for Low Voltage Lighting Systems

First Edition – February, 2004

Second Edition

December 7, 2015

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through April 18, 2023.

The most recent designation of ANSI/UL 2108 as an American National Standard (ANSI) occurred on April 18, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements apply to low voltage lighting systems and components intended for installation in accordance with the National Electrical Code, NFPA 70, Article 411.

1.2 These requirements cover:

a) Power units in which output is limited to 25 A and below the risk of electric shock voltage levels as defined in 3.19; and

b) Class 2, exposed bare conductor, POE, and other low-voltage luminaires and lighting systems.

1.3 These requirements do not cover lighting equipment covered by other standards such as, but not limited to, the Standard for Portable Electric Luminaires, UL 153, the Standard for Track Lighting Systems, UL 1574, or the Standard for Luminaires, UL 1598:

a) Luminaires provided with a cord and attachment plug intended for branch circuit connection. See the Standard for Portable Electric Luminaires, UL 153.

b) Luminaires intended to be mounted to and relocatable along a track, including when the track is supplied at low voltage. See the Standard for Track Lighting Systems, UL 1574.

c) Luminaires intended to be carried by hand or exclusively used not connected to a branch circuit. See the Standard for Flashlights and Lanterns, UL 1576.

d) Luminaires integrated with a power unit in a singular product. See the Standard for Luminaires, UL 1598.

1.4 Light emitting diode (LED) components, controls, and subassemblies integral to a low voltage lighting system shall comply with the applicable requirements of the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750.

1.5 These requirements do not address certain specialized applications, including but not limited to hazardous/classified locations, emergency lighting, marine (ship-board) lighting, horticultural systems, germicidal luminaires, air-handling luminaires, or luminaires installed over cooking equipment. Low voltage lighting system equipment intended for such applications are to be investigated in accordance with standards written for the purpose.

2 Units of Measurement

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

3 Glossary

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

3.2 ACCESSIBILITY BARRIER – A material provided to limit access to uninsulated current-carrying parts that involve a risk of shock and insulated current-carrying parts not intended to be subject to user contact.

3.2.1 BATTERY – General term for (1) any single cell, or (2) a group of cells connected together either in a series and/or parallel configuration. May be ready for use or may be an installed component.

3.2.2 BATTERY CELL – The basic manufactured unit of a battery. Provides electrical energy by direct conversion of chemical energy and designed to be charged electrically. Consists of electrodes, separators, electrolyte, container and terminals.

3.2.3 BATTERY, SECONDARY – A battery intended to be charged and discharged multiple times under prescribed rates of charging and discharging in accordance with the battery manufacturer's recommendations.

3.3 CABINET MOUNTED UNIT – A luminaire or power unit intended for final installation into cabinets and similar location, such that all or part of the unit is located within the interior space of the cabinet.

3.4 CONDUCTORS, INSULATED – A conductor encased within material recognized as electrical insulation.

3.5 ENCLOSURE – A material provided to enclose electrical parts and components that involve a risk of fire, and to protect internal parts from the environment and from mechanical damage. All or part of the enclosure is not prohibited from also serving as an accessibility barrier or recessed housing.

3.6 EXPOSED CONDUCTORS – Low voltage supply conductors with no additional housing, which provide physical support and electrical supply connections for one or more luminaire assemblies, including assemblies capable of being repositioned along the length of the conductors. Does not include lighting track bus bars (see UL 1574 clause 3.4) which may be accessible within their housing.

3.6A HOUSING – A protective casing for a device that is not required to meet the construction or performance criteria of an enclosure.

3.7 LAMP CONTAINMENT BARRIER – Any part of the luminaire that surrounds the lamp to contain hot particles of the lamp in the event that it ruptures.

3.8 LOCATION, DAMP – An exterior or interior location that is normally or periodically subject to condensation of moisture in, on, or adjacent to electrical equipment, and includes partially protected locations.

3.9 LOCATION, DRY – A location not normally subject to dampness, but may include a location subject to temporary dampness, as in the case of a building under construction, provided ventilation is adequate to prevent an accumulation of moisture.

3.10 LOCATION, WET – A location in which water or other liquid may drip, splash, or flow on or against electrical equipment.

3.11 LOW VOLTAGE LUMINAIRE – A lighting unit intended for connection to a power source for which output voltage does not represent a risk of electric shock.

3.12 NOMINAL OUTPUT WATTAGE/LOAD – Specified by power unit or system manufacturer as total lamp wattage. Assumes that lamps are operating at rated lamp voltage.

3.13 *Deleted*

3.13.1 OPEN DEVICE – A component or subassembly with instructions that limit installation to within enclosures of metal or nonmetallic materials suitable for fire containment and that limits user access to parts representing a risk of electric shock.

3.14 *Deleted*

3.14.1 *Deleted*

3.15 POWER UNIT – The equipment that powers and controls the luminaires in a low voltage lighting system. A power unit has the following characteristics:

a) An isolating type transformer or electronic power supply of output voltage not exceeding the risk of electric shock;

b) Is intended for field installation; and

c) Each secondary circuit is limited to 25 A.

3.16 POWER OVER ETHERNET (PoE) – A DC power system conforming to IEEE 802.3 that uses category 5 (CAT5) or similar cables and 8P8C (RJ45) modular connectors to concurrently carry power and data between the power source and powered device. The voltage and power of all PoE systems are within the class 2 limits of NFPA 70, and therefore are given comparable treatment within this standard.

3.17 RECESSED HOUSING – A part of a recessed luminaire or power unit that projects into the ceiling or wall cavity and serves to close off the opening from the room side, and does not necessarily enclose conductors or similar components.

3.18 RECESSED EQUIPMENT – Equipment intended to be installed through (penetrating) or located above the mounting surface, and identified as one of the following:

Inherently Protected - Suitable for installation where in direct contact with thermal insulation or combustible materials, without reliance on a thermal protector to limit operating temperatures.

Type IC, Thermally Protected – Suitable for installation where in direct contact with thermal insulation or combustible materials.

Type Non-IC, Thermally Protected – Suitable for installation with minimum dimensions and spacings to thermal insulation or combustible materials in accordance with the installation code.

Type Non-IC, Concrete Only – Suitable for installation only in poured concrete.

3.19 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 a 1500 Ω resistor in parallel with a 0.015 µF capacitor connected between the two points exceeds a 5 mA and if the open circuit voltage exceeds the following limits in Table 3.1.

Table 3.1
Risk of electric shock voltage limits

Waveform type[a]	Maximum Voltage	
	Dry and damp locations	Wet locations
Sinusoidal ac	30 V rms	15 V rms
Non-sinusoidal ac	42.4 V peak	21.2 V peak
Continuous dc[b]	60 V	30 V
10 – 200 Hz interrupted dc[c]	24.8 V	12.4 V

[a] For a combined ac + dc waveform, the dry and damp location voltage limit shall be the non-sinusoidal ac limit where the dc voltage is no more than 20.9 V, and shall be (33 + 0.45Vdc) where the dc voltage is greater than 20.9 V. The wet location voltage limit shall be half this amount.

Table 3.1 Continued on Next Page

Table 3.1 Continued

Waveform type[a]	Maximum Voltage	
	Dry and damp locations	Wet locations
[b] If the peak-to-peak ripple voltage on a dc waveform exceeds 10% of the dc voltage, the waveform shall be considered a combined waveform per footnote a above.		
[c] Contact with interrupted dc at a lower or higher frequency shall be permitted only after a special investigation based on the specific waveform parameters.		

3.19.1 RISK OF FIRE – a risk of fire exists in an electrical circuit or device if the maximum voltage (V), current (I), or power (V x I) exceeds the applicable class 2 limit defined in Table 11(A) (for AC circuits) or 11(B) (for DC circuits) of NFPA 70.

3.20 SURFACE MOUNT UNIT – A luminaire or power unit that is designed to be mounted on the room side of a wall, ceiling, or other surface.

3.21 *Deleted*

3.22 UNDER-CABINET OR SHELF-MOUNTED UNIT – A luminaire and/or power unit intended for surface or blind hole mounting under a cabinet or shelf, where the unit does not extend through the mounting surface or into the cabinet interior.

3.23 *Deleted*

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

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

5 Undated References

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

5.2 The following publications are referenced in this Standard:

ASTM E230/E230M, Standard Specification and Temperature-Electromotive Force Tables for Standardized Thermocouples

IEEE 802.3, Standard for Ethernet

NFPA 70, National Electrical Code

NFPA 90A, Installation of Air-Conditioning and Ventilating Systems

UL 13, Power-Limited Circuit Cables

UL 62, Flexible Cords and Cables

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

UL 153, Portable Electric Luminaires

UL 444, Communications Cables

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

UL 758, Appliance Wiring Material

UL 796, Printed-Wiring Boards

UL 873, Temperature-Indicating and -Regulating Equipment

UL 879, Electric Sign Components

UL 924, Emergency Lighting Equipment

UL 969, Marking and Labeling Systems

UL 1012, Power Units Other Than Class 2

UL 1097, Double Insulation Systems for Use in Electrical Equipment

UL 1310, Class 2 Power Units

UL 1411, Transformer and Motor Transformers for Use in Audio-, Radio- and Television-Type Appliances

UL 1574, Track Lighting Systems

UL 1577, Optical Isolators

UL 1598, Luminaires

UL 1642, Lithium Batteries

UL 1838, Low Voltage Landscape Lighting Systems

UL 2043, Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces

UL 2054, Household and Commercial Batteries

UL 2097, Reference Standard for Double Insulation Systems for Use in Electronic Equipment

UL 4200A, Products Incorporating Button or Coin Cell Batteries of Lithium Technologies

UL 5085-1, Low Voltage Transformers – Part 1: General Requirements

UL 5085-2, Low Voltage Transformers – Part 2: General Purpose Transformers

UL 5085-3, Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

UL 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products

UL 60730-1, Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements

UL 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements

UL 62133-1, Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made from Them, for Use in Portable Applications – Part 1: Nickel Systems

UL 62133-2, Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made from Them, for Use in Portable Applications – Part 2: Lithium Systems

UL 62368-1, Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements

6 Organization and Application

6.1 *Deleted*

PART I – POWER UNITS

GENERAL

7 General

7.1 These requirements apply to the power units in a low voltage lighting systems.

7.2 The maximum rating of a power unit shall not exceed the risk of electric shock voltage, or 25 A per circuit, under any conditions of load.

7.3 The low voltage secondary circuit shall be isolated from the primary circuit. If the secondary circuit output exceeds NEC Article 725 class 2 limits, it shall not be grounded.

CONSTRUCTION – MECHANICAL

8 General Construction

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

a) Rolling the edges of the metal not less than 120 degrees;

b) A bushing or grommet of a material other than rubber at least 0.047 in (1.2 mm) thick;

c) Glass sleeving at least 0.010 in (0.25 mm) thick; or

d) Other means that provide equivalent protection.

8.2 A component such as a lampholder, switch, or other part of an assembly shall be restricted from loosening or turning when such motion adversely affects the intended performance of a component, a reduction of electrical spacings, or results in a risk of fire. Friction alone does not meet the intent of restriction of movement. The use of a lock washer, a star washer, dimples, upturned lugs, ears, and similar means meets the intent of the requirement for this purpose.

9 Enclosure

9.1 All current-carrying parts that present a risk of fire or of electric shock shall be enclosed in material specified in 9.2 – 9.4, and assembled per 9.6.

Exception: Open devices and Exposed Bare and Insulated Conductors compliant with Section 30.

9.2 The thickness of sheet and extruded metal in a power unit enclosure shall be in accordance with Table 9.1.

Table 9.1
Minimum thickness of sheet metal and extruded aluminum for enclosures

Specific construction		Steel				Copper, brass, aluminum sheet, and extruded aluminum			
		Unreinforced		Reinforced		Unreinforced		Reinforced	
		in	(mm)	in	(mm)	in	(mm)	in	(mm)
At opening for conduit connection		0.026	(0.66)	0.026	(0.66)	0.032	(0.81)	0.032	(0.81)
Length more than 26 in (660 mm)	No electrical component support	0.020	(0.51)	0.016	(0.41)	0.022	(0.56)	0.017	(0.43)
	Electrical component support	0.026	(0.66)	0.020	(0.51)	0.028	(0.71)	0.022	(0.56)
Length not more than 26 in (660 mm)	No electrical component support	0.016	(0.41)	0.013	(0.33)	0.020	(0.51)	0.016	(0.41)
	Electrical component support	0.020	(0.51)	0.016	(0.41)	0.025	(0.64)	0.020	(0.51)
Length not more than 15 in (380 mm)	No electrical component support	0.016	(0.41)	0.013	(0.33)	0.020	(0.51)	0.016	(0.41)
	Electrical component support	0.016	(0.41)	0.016	(0.41)	0.020	(0.51)	0.020	(0.51)
Notes: (1) Reinforced – a form of construction that provides equivalent mechanical strength.									

Table 9.1 Continued on Next Page

Table 9.1 Continued

Specific construction	Steel				Copper, brass, aluminum sheet, and extruded aluminum			
	Unreinforced		Reinforced		Unreinforced		Reinforced	
	in	(mm)	in	(mm)	in	(mm)	in	(mm)
(2) No electrical component support – the minimum thickness required for mounting of non-electrical parts. (3) Examples of acceptable methods of reinforcement are: a) a single piece of sheet metal that is formed to result in a maximum internal angle of 120 degrees; b) 0.5 by 0.5 in (13 by 13 mm) 90 degrees formed from sheet steel, 0.266 in (8.1 mm) minimum thickness, used to divide a surface into small sections and, unless along the greater dimension, are additionally secured to the adjacent sides of the enclosure; c) flat steel bars, 0.375 in (9.5 mm) wide minimum, 0.125 in (3.2 mm) thick minimum, used and secured as in (b); and d) curved, ribbed, or flanged surfaces. A surface is considered to be flanged if the two opposite sides are bent 0.50 in (13 mm) or wider at right angles to the surface. (4) For coated or finished metals, the minimum thickness is considered to be obtained if the overall thickness exceeds that required in this table by at least 0.0005 in (0.013 mm) for each side coated or finished. (5) Length – the longest straight line that can be drawn on any unreinforced flat section.								

9.3 The thickness of an enclosure material constructed of cast metal shall be in accordance with Table 9.2.

Table 9.2
Minimum thickness of cast metal for enclosures

Material	Unreinforced		Reinforced	
	in	(mm)	in	(mm)
Cast metal	0.126	(3.2)	0.094	(2.4)
Cast malleable iron	0.094	(2.4)	0.063	(1.6)
Permanent mold – cast aluminum	0.094	(2.4)	0.063	(1.6)
Die cast metal	0.079	(2.0)	0.047	(1.2)
Note: Reinforced dimensions are usable at the root of threads, a surface that is curved or otherwise reinforced; and for a surface of such shape, or size, or both, that the strength contemplated is provided. Areas for breakouts, or similar reasons, are able to have thinner sections, when the strength of structure is not affected, and in no case thinner than required for sheet metal.				

9.4 An enclosure formed of a polymeric material, shall comply with the Impact, Flammability, Mold Stress, and Relative Temperature Index (RTI) of UL 746C.

Exception: When the temperature measured during the normal temperature test is less than 65°C (149°F), the enclosure is not required to comply with the RTI requirement.

9.5 A polymeric material relied upon to provide all or a portion of the strain relief shall comply with the requirements of the Strain Relief for Flexible Cord Test, Section 41, after the Mold Stress Relief Distortion Test in UL 746C.

9.6 An enclosure shall be assembled to provide the mechanical strength required to resist the expected conditions of use without resulting in a risk of fire, electric shock, or injury to persons due to total or partial failures that cause reduction of spacings (electrical or thermal), loosening or displacement of parts, or

other serious defects. Where an enclosure relies on adhesive, the adhesive shall be suitable for the associated temperature, environmental exposure, surface materials, and mechanical forces.

10 Openings

10.1 All splices, open coil devices, capacitors, leads or terminals for field connection of supply wires, other arcing live parts, or current-carrying parts involving a risk of fire or shock shall be provided with an enclosure of a material specified in Enclosure, Section 9 without any open holes.

Exception: Open holes are able to be used when all uninsulated current-carrying parts or splices involving a risk of shock as defined in 3.19 are not accessible by the accessibility probe shown in Figure 22.1 and the open holes do not exceed the dimensions specified in 10.2.

10.2 An open hole in the enclosure shall not exceed 1-1/2 in^2 (968 mm^2) in area, and the total area of one or more open holes shall not be more than 15% of the area of the surface in which the hole or holes are located.

Exception: A higher percentage of surface area may be open where the materials and configuration of the surface retain sufficient mechanical integrity for the application.

10.3 An enclosure containing a fuse mounted in an open type fuseholder shall have no open holes.

Exception: Openings in an enclosure containing an open type fuseholder are able to be located 6 in (152 mm) or more from the fuse, measured horizontally, when the power unit is mounted as intended.

10.4 *Deleted*

11 Recessed Housings

11.1 A recessed product shall be constructed such that a hole in a ceiling or wall structure is closed off by the recessed housing.

11.2 A sheet metal recessed housing shall have a minimum thickness of 0.026 in (0.66 mm) when of steel, and 0.028 in (0.71 mm) when of aluminum or copper alloy.

11.3 A polymeric recessed housing shall have a generic or relative temperature index equal to or greater than the highest temperature measured on the part during the normal temperature test.

11.4 *Deleted*

11.5 A recessed housing shall comply with Section 10, Openings.

11.6 The recessed housing of a product marked for use in poured concrete or in ground shall contain no open holes.

11.7 The recessed housing of a product marked “TYPE IC RECESSED” shall contain no open hole as a slot or louver larger than 3/16 in (4.8 mm) in width. Any other shape of an open hole shall be such that it does not permit the entrance of a 1/4 in (6.4 mm) diameter rod.

11.8 The recessed housing of a product marked “TYPE NON-IC RECESSED” shall contain no open hole as a slot or louver larger than 3/8 in (9.5 mm) in width. Any other shape of an open hole shall be such that it does not permit the entrance of a 1 in (25.4 mm) diameter rod.

11.9 The total area of all open holes in a recessed luminaire housing shall be no more than 15 % of the area of the inside diameter of the recessed housing or plaster frame where the housing or frame passes through the hole in the mounting surface.

Exception: A higher percentage of surface area may be open where the materials and configuration of the surface retain sufficient mechanical integrity for the application.

11.10 A polymeric recessed housing shall be marked as specified in 48.5.7.

11A Equipment for Use in Environmental Air-Handling Spaces (Plenums)

11A.1 Equipment with polymeric enclosure parts intended to be installed in air-handling spaces[a] shall comply with the requirements in UL 2043.

[a] Equipment evaluated in accordance with these requirements is considered to comply with the fire retardant and low smoke producing requirements of Section 300.22(C) of the National Electrical Code, NFPA 70; Chapter 4 of Standard for the Installation of Air-Conditioning and Ventilating Systems, NFPA 90A; Section 602 of the International Mechanical Code; and Section 602 of the Uniform Mechanical Code.

11A.2 Equipment that complies with 11A.1, and equipment with a metal enclosure (even if that enclosure is ventilated), is permitted to be marked in accordance with 48.1.9.

12 Corrosion Protection

12.1 Ferrous metal parts of the enclosure not inherently corrosion resistant shall be protected against corrosion by enameling, galvanizing, zinc or cadmium plating, or other equivalent means.

12.2 Edges, punched holes, and spot welds in prefinished steel, enclosed steel pipe, and hanger locations for painting or plating in ferrous metals do not require any corrosion protection.

13 Damp and Wet Locations

13.1 Products marked suitable for wet locations in accordance with 48.2.12 shall comply with the wet location construction and performance requirements of UL 1598.

13.2 Products marked suitable for damp locations in accordance with 48.2.13 shall comply with the following:

a) Ferrous metal parts shall be protected against corrosion by enameling, galvanizing, zinc or cadmium plating, or other equivalent means; and

b) The product shall not be provided with any information such as markings, instructions, or illustrations either on the carton or with the product that implies or depicts a wet location use.

13.3 Power units intended for exposed bare conductor lighting systems shall not be marked suitable for wet or damp locations.

CONSTRUCTION – ELECTRICAL

14 Current-Carrying Parts

14.1 All current-carrying parts shall be made of copper or copper alloy.

Exception: Aluminum and aluminum alloys are permitted to conduct current in the output circuit of exposed bare conductor lighting systems.

15 Conductors and Cords

15.1 Wiring not protected in accordance with Exposed Bare and Insulated Conductors, Section 30 shall consist of general use wire or appliance wiring material with insulation rated for the maximum temperature and voltage of the unit.

15.2 Conductors shall be 18 AWG (0.82 mm^2) minimum.

Exception No. 1: Conductors of a size smaller than 18 AWG, but not smaller than 24 AWG (0.20 mm^2), 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 using solid-state devices.

Exception No. 2: Conductors of any size are permitted when the conductors are in Class 2 or equivalent isolated low voltage, limited energy circuits only and are physically separated from all other non-Class 2 or non-isolated low voltage, limited energy circuits, such as by a barrier or reliably fixed spacing of minimum 0.25 in (6.4 mm).

15.3 The maximum ampacity of 18 AWG (0.82 mm^2) or larger wire and cord with copper conductors shall be in accordance with Table 15.1.

Exception: A conductor is not required to be sized in accordance with Table 15.1 when it complies with the Direct-Current Bus-Bar or Conductor Resistance Test described in UL 1574.

Table 15.1
Maximum ampacities of wire and cords

Types of wire and cord[a]	Ampacity[b]				
	18 AWG (0.82 mm^2)	16 AWG (1.3 mm^2)	14 AWG (2.1 mm^2)	12 AWG (3.3 mm^2)	10 AWG (5.3 mm^2)
General building wire (Conductors for general wiring)	–	–	20	25	30
Fixture wire	6	8	17	23	28
Flexible cord[c]	10	13	18	25	30
Appliance wiring material	6	8	17	23	28

[a] Except for appliance wiring material, see NFPA 70, for required wire and cord types covered by these designations.

[b] The SI equivalent for each conductor size is shown in parentheses in terms of cross-sectional area.

[c] These ampacities are applicable to 2-conductor cords carrying current.

16 Splices and Connections

16.1 A splice made with solder or a wire connector shall be electrically and mechanically secure.

16.2 An insulated splice or connector shall be provided with insulation that has temperature and voltage ratings equal to or greater than required for the conductor insulation.

16.3 Soldered connections to printed wiring boards shall be secured by one of the following methods:

a) A conductor passed through a hole and soldered on the opposite side.

b) A solder connection covered with epoxy, silicone rubber, or potting.

c) A surface mount connection with solder reflow.

d) A conductor held rigidly in place (without the use of solder) so as to preclude any movement at the point of electrical connection.

e) Surface Mount Device (SMD) components and components without integral leads soldered to the printed wiring board. Surface mounted connector receptacles and associated connectors with leads are acceptable without additional mechanical securement where the lead wires are not subject to movement after assembly.

f) Where supplied by a Class 2 or LVLE source, solder alone is sufficient if detachment will not reduce spacings of electrical parts to non-Class 2 or non-LVLE circuits below the applicable required spacings.

g) A wave-solder connection to a metal-clad printed-circuit board without any further mechanical security.

h) Any other method that offers mechanical securement of the connection before soldering.

17 Transformer

17.1 The primary and secondary windings of a transformer shall be isolated and comply with one of the following:

a) UL 5085-1, and UL 5085-2;

b) UL 5085-1, and UL 5085-3;

c) UL 1411;

d) UL 1838;

e) UL 1012; or

f) UL 1310.

17.2 A Class 2 power unit employing a transformer shall comply with the Class 2 requirements of UL 5085-1, and UL 5085-3, or UL 1310.

17.3 The construction of a transformer in a power unit marked suitable for wet locations shall comply with at least one of the following:

a) Primary and secondary windings mounted on separate sections of the core;

b) Primary and secondary windings separated by a shield of copper minimum 0.002 in (0.051 mm) thick, or brass, minimum 0.005 in (0.127 mm) thick;

c) A flanged bobbin-wound construction that complies with UL 1012;

d) A split bobbin construction and comply with the requirements for double insulation in UL 1097, or UL 2097;

e) UL 1411, construction, performance, and 3500 V rms dielectric voltage withstand test requirements;

f) The Class 2 requirements in UL 5085-1, and UL 5085-3; or

g) UL 1310 and be marked as double insulated.

17.4 The shield in 17.3(b) shall be bonded to the transformer core and to the power unit grounding means. The bonding shall comply with the Grounding Continuity Test, Section 40.

Exception: Bonding the shield to the core is not required for a toroidal type transformer when the transformer is isolated from ground.

17.5 A connection shall be made between the shield and ground by means of a bonding lead sized at least as large as the conductor used to supply the primary winding magnet wire, and shall be no smaller than 18 AWG (0.82 mm^2).

18 Electronic Power Supply

18.1 An electronic power supply of a power unit shall comply with the electrical construction and performance requirements of one of the following standards:

a) UL 1012;

b) UL 1310;

c) UL 60950-1; or UL 62368-1;

d) UL 879; or

e) UL 8750.

18.2 A power unit that complies with the applicable output performance requirements of UL 1310, is permitted to be marked in accordance with 48.2.10. A power unit whose output complies with (a), (b), or (c) below is permitted to be marked in accordance with 48.2.11:

a) The LPS (limited power source) parameters of UL 60950-1;

b) The LVLE (low voltage limited energy) parameters of UL 8750 where the marked wattage or VA is 100 or less; or

c) The Limited Power Source Test of UL 2054.

18.3 A power unit with an electronic power supply shall isolate the primary from the secondary by such means as optical isolators that comply with the UL 1577, or transformers that comply with Transformer, Section 17.

19 Protective Devices

19.1 Each output of the power unit shall be limited to a maximum of 25 A, either by design or by operation of a protective device. Compliance shall be determined by the Maximum Output Test, 33.2.2.

19.2 An overcurrent protective device shall comply with the appropriate Standard.

19.3 A nonresettable thermal protective device shall be inaccessible and shall be located within the enclosure.

19.4 An automatic reset protective device shall comply with the 6,000 Cycle Endurance Test in UL 873, or shall be rated for 6,000 cycles in accordance with UL 60730-1. Compliance with UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

19.5 A power unit having available power exceeding Class 2 limits and intended for an exposed bare conductor lighting system shall comply with the Exposed Bare Conductor Abnormal Operation Test described in Section 38.

19.6 A recessed product shall be provided with thermal protection rated for the maximum rated load it controls and comply with the requirements for thermal protective devices for lighting fixtures or fluorescent lamp ballast protectors, as specified in UL 873, or in UL 60730-1. Compliance with UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

Exception No. 1: A power unit marked for use only in poured concrete or in-ground as specified in 48.5.3 is not required to be provided with thermal protection.

Exception No. 2: Thermal protection is not required to be provided on an inherently protected power unit that operates within the Type IC temperature limits in Table 34.1 with the maximum rated load and is marked in accordance with 48.5.1(c).

20 Electronic Circuits

20.1 The requirements in this section do not apply to components located in a Class 2 circuit.

20.2 A printed wiring board, including coatings, when provided shall comply with the requirements in UL 796, and shall be classified V-0, V-1, or V-2 in accordance with UL 94.

20.3 A resistor, capacitor, inductor, transformer, or other part that is mounted on a printed wiring board to form a printed-wiring assembly shall be secured so that the risk of displacement by any force exerted on it is minimized.

20.4 A circuit involving a capacitor, rectifier, transistor, or similar component is to be subjected to analysis to determine whether there is a risk of fire or electric shock when the component is opened or shorted. The possible effect of one component on another, encapsulation, and similar factors are to be considered. When a risk is determined to exist, the Component Fault Test, Section 39 is to be conducted.

21 Switches

21.1 The requirements in this section do not apply to components located in a Class 2 circuit.

21.2 A switch shall have a minimum ampere rating equal to the total load current it controls multiplied by the load factor shown in Table 21.1.

Table 21.1
Switch rating load factor

Type of load	Special use switches				General use switches
	L-rated (ac only)	T-rated (ac/dc)	Ampere rated (ac only)	Ampere rated (ac/dc)	Ampere rated (ac only)
Tungsten filament	1	1	3	3	1
Inductive	1	1	2	2	1
Resistive	1	1	1	1	1

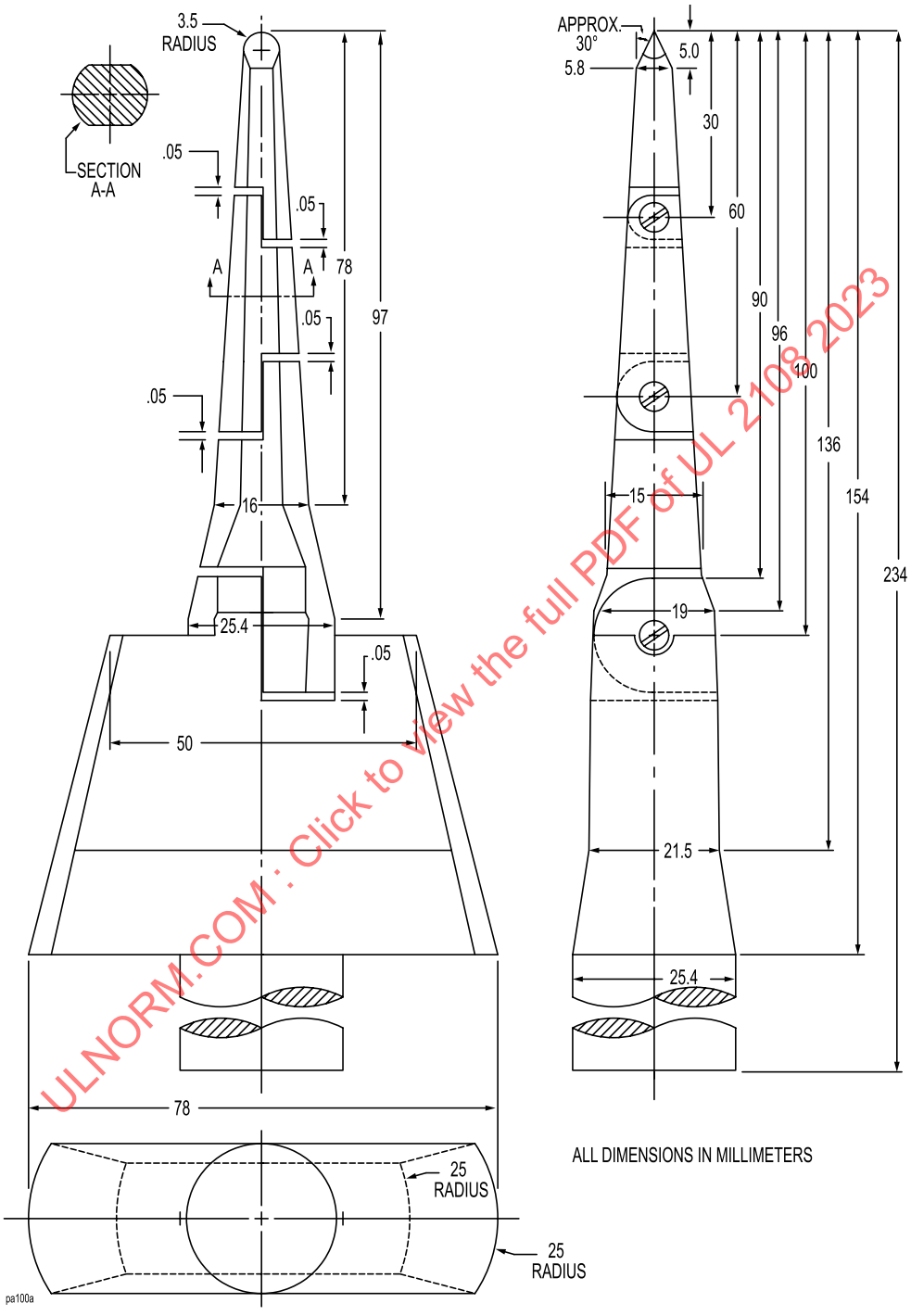
22 Accessibility to Live Parts

22.1 An uninsulated current-carrying part or a splice connection involving a risk of shock as defined by 3.19 shall be inaccessible to unintentional contact by persons during use. Any parts removable without a tool are to be removed prior to making the accessibility determination.

22.2 An uninsulated current-carrying part or a splice connection is determined to be accessible when it is contacted by the articulated probe shown in Figure 22.1.

Figure 22.1

Articulate probe with web stop



NOTES:

The UL articulate probe without the web stop is capable of being used for openings having a minor dimension less than 3/4 in (19.1 mm).

High impact polystyrene articulate probes are available from Underwriters Laboratories Inc.

23 Electrical Spacings

23.1 Each spacing between current-carrying parts of opposite polarity and between live and dead metal parts shall not be less than those specified in Table 23.1.

Exception No. 1: The spacing requirements do not apply to components located in a Class 2 circuit.

Exception No. 2: A minimum spacing of 0.010 in (0.25 mm) shall be maintained through air and over surface in secondary circuits of exposed bare conductor systems.

Table 23.1
Spacings

Spacing involved			Minimum spacing							
			0 – 50 V rms[a]		51 – 150 V rms[a]		151 – 300 V rms[a]		301 – 600 V rms[a]	
			in	(mm)	in	(mm)	in	(mm)	in	(mm)
Between uninsulated current-carrying parts and -	Uninsulated current-carrying parts of opposite polarity	Through air	1/16	(1.6)	1/8	(3.2)	1/4	(6.4)	3/8	(9.5)
		Over surface	1/16	(1.6)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
	Exposed dead metal parts that are isolated (insulated)	Through air	1/16	(1.6)	1/8	(3.2)	1/4	(6.4)	3/8	(9.5)
		Over surface	1/16	(1.6)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)

[a] For peak voltages, multiply applicable rms voltage by the square root of 2.

23.2 The spacing between uninsulated current-carrying parts of different circuits involving different voltages shall not be less than that required for the circuit of the higher voltage.

24 Electrical Barriers

24.1 A barrier or liner of insulating material that is used to maintain spacings shall be not less than 0.025 in (0.64 mm) thick when the material is treated fiber or of phenolic composition.

Exception No. 1: Other materials of the same or different thickness are not prohibited from being used when determined to meet the intent of the requirement.

Exception No. 2: A barrier that is securely held in place and not exposed or otherwise subject to damage after installation shall be not less than 0.013 in (0.33 mm) thick.

25 Electrical Insulation

25.1 Polymeric material in direct contact with or within 1/32 in (0.8 mm) of current-carrying parts shall comply with the requirements in UL 746C. Among the factors to be evaluated are:

a) Resistance to Electrical Ignition Sources – Only the Hot Wire Ignition (HWI) shall be evaluated. The Performance Level Category (PLC) requirement depends on the flame rating of the material. See Table 25.1.

b) Flammability – minimum HB.

c) Temperature – The material shall have an electrical temperature rating at least the temperature measured on the part during the Normal Temperature Test.

Exception: These requirements do not apply to the secondary circuits of Class 2 or exposed bare conductor systems.

Table 25.1
Flame rating

Flame rating	HWI PLC
HB	2
V-2	2
V-1	3
V-0	4

25.2 Polymeric materials in direct contact with or within 1/32 in (0.8 mm) of current-carrying parts in secondary circuits shall have a minimum flammability rating of HB or HBF.

Exception No. 1: The HB or HBF flame rating does not apply to small parts not exceeding 0.122 in^3 (2 cm^3).

Exception No. 2: The HB or HBF flame rating does not apply to materials with an exposed edge not exceeding 0.04 in (1 mm) thick and sandwiched between two metal parts.

26 Separation of Circuits

26.1 Secondary circuits shall be separated from other circuits in accordance with 26.2 – 26.6. Insulated conductors shall be separated by barriers or segregated from:

a) Each other when used in different internal wiring circuits; and

b) Uninsulated current carrying parts connected to different circuits.

Exception: Separation is not required when all conductors are provided with insulation rated for the highest voltage involved.

26.2 Segregation of insulated conductors shall be accomplished by clamping, routing, or equivalent means that results in permanent separation from insulated or uninsulated current carrying parts of a different circuit.

26.3 Means shall be provided for separation of field-installed conductors of the secondary circuit from:

a) Field and factory-installed conductors connected to any other circuit.

Exception: Complete instructions in conjunction with a wiring diagram is able to be used in lieu of a barrier when, upon investigation, the combination is found to meet the intent of the requirement and the instructions specify that the conductors of both circuits are to be insulated for the maximum voltage of either circuit.

b) Uninsulated current carrying parts of any other circuit of the device.

26.4 Segregation of field-installed conductors from each other and from uninsulated current carrying parts of the equipment connected to different circuits is attainable by arranging the location of openings in an enclosure for the various conductors with respect to the terminals or other uninsulated current carrying parts so that conductors or parts of different circuits do not intermingle.

26.5 With reference to 26.4, the opening shall be evaluated such that a conductor entering the opening is connected to the terminal opposite that opening. When more than the minimum number of openings are provided, the risk of a conductor entering an opening other than the one opposite the terminal to which it is intended to be connected shall be evaluated. The risk of such a conductor contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit shall be evaluated.

26.6 To determine compliance with 26.2, the equipment is to be wired as intended for service with an amount of slack left in each conductor within the enclosure and average care is to be exercised in stowing the slack into the wiring compartment.

27 Grounding and Bonding

27.1 A power unit provided with a metal enclosure or a metal shield shall be provided with an equipment grounding means.

27.2 All conductive parts of a power unit not intended to be electrically live, that are accessible to persons and that are able to inadvertently become energized, shall be grounded by being conductively bonded to a common point that incorporates provision for grounding of the power unit.

Exception: The power unit need not be grounded when it is double insulated in accordance with UL 2097. The value used for the Leakage Current Test is 0.5 mA. The Overload Test described in Section 36 shall be used rather than the test described in UL 2097.

27.3 A conductive part that is required to be grounded in accordance with 27.2, and that is coated with vitreous enamel, paint, or similar coatings, is required to be bonded. When required, the part is to be treated by masking, removal of the coating at points of connection, or the use of fastening means that penetrate the surface coating. When special treatment is necessary or when ground continuity is not obvious, the grounding continuity shall be determined by the method described in Grounding Continuity Test, Section 40.

27.4 The continuity of the grounding system shall not rely on the dimensional integrity of a polymeric material.

Exception: This requirement does not apply to material investigated and found to comply with UL 746C.

27.5 A grounding means shall consist of a pigtail lead grounding conductor, a pressure terminal connector, a wire binding screw, the grounding contact of a receptacle, the grounding pin of an attachment plug, or the equivalent. The grounding means shall be at the same location as the power supply connection means.

27.6 An equipment grounding conductor shall not be smaller in size than the current carrying supply conductor and in no case shall it be smaller than 18 AWG (0.82 mm^2). When insulated, the equipment grounding conductor, where visible to the installer, shall have a braid of continuous green color with or without a yellow tracer or, when no braid is employed, the insulation on the conductor shall be green with or without one or more yellow stripes. A conductor having green insulation and a braid of other than green is also able to be employed when the green insulation is readily visible where connections to the branch-circuit supply wires will be made.

27.7 An equipment grounding conductor shall not be terminated to another device or part that is removable during replacement of any device or component.

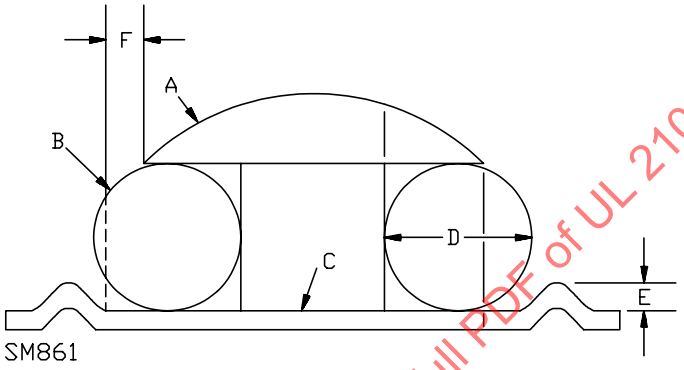
27.8 A wire binding screw intended for the field connection of an equipment grounding conductor shall have a green colored head that is hexagonal shaped, slotted, or both.

27.9 A wire binding screw, described in 27.8 shall be No. 8 [4.2 mm (major diameter)] or larger and shall be provided with a cupped washer or similar means to hold the wire under the head of the screw. A sheet metal screw is not usable for grounding.

Exception: A cupped washer is not required to be provided when the terminal plate is provided with two raised areas around the tapped hole that are at least 1/4 in (6.4 mm) apart (on center) and comply with Figure 27.1.

Figure 27.1

Terminal-conductor relationship



A – Wire Binding Screw

B – Conductor

C – Terminal Plate

D – Maximum conductor diameter, but not less than 0.08 in (2 mm)

E – Minimum height of raised areas = 0.04 in (1.0 mm)

F – The horizontal dimension from the edge of the screwhead to the inside edge of the raised area = 0 to 1/4 D

27.10 A pressure wire terminal intended for the field connection of an equipment grounding conductor shall be plainly identified by being marked in accordance with 48.2.6.

27.11 A terminal plate having a tapped hole for a wire binding screw shall be of metal no less than 0.030 in (0.76 mm) in thickness and shall have no fewer than two full threads in the metal.

28 Supply Connections

28.1 A power unit shall be provided with a permanent means of connection to a branch circuit, such as:

a) Provision for mounting over a standard outlet box;

b) Provision for connection to conduit or cable;

c) A length of flexible cord without attachment plug; or

d) Other means in accordance with NFPA 70.

Exception No. 1: A power unit intended for use with exposed bare conductor lighting systems is permitted to be provided with flexible cord and an attachment plug.

Exception No. 2: A POE-enabled power unit intended for rack (or similar) mounting where the cord is not concealed, is permitted to be provided with flexible cord and an attachment plug.

28.2 Flexible cord shall not be used for a supply connection means that is intended to be:

a) Concealed or extended through a wall, floor, ceiling, or similar building structure such as a kitchen cabinet;

b) Located above a suspended ceiling or dropped ceiling;

c) Not visible for its entire length; or

d) Subject to strain or physical damage.

28.3 The means for connection shall consist of pigtail leads, terminal block, pressure terminal connector, power supply cord, or equivalent means.

28.4 An opening for conduit and the minimum unobstructed diameter of the flat surface surrounding the back of the opening for unthreaded conduit shall have dimensions as indicated in Table 28.1.

28.5 A threaded opening for conduit shall:

a) Have no fewer than 3-1/2 or more than 5 threads when tapped all the way through the opening;

b) Have at least 5 full threads when not tapped all the way through the opening;

c) The unthreaded part of the opening shall be smooth and well rounded for protection of the conductors; and

d) The unthreaded throat diameter of the hole shall have an internal diameter as noted in Table 28.1.

Table 28.1
Dimensions associated with openings for conduit

Nominal trade size of conduit	Unthreaded opening diameter[a]		Throat minimum		Diameter maximum		Minimum diameter of flat surface	
in	in	(mm)	in	(mm)	in	(mm)	in	(mm)
1/2	0.875	(22.2)	0.56	(14.2)	0.62	(15.7)	1.15	(29.2)
3/4	1.109	(28.2)	0.74	(18.8)	0.82	(20.8)	1.45	(36.8)
1	1.375	(34.9)	0.94	(23.9)	1.05	(26.7)	1.80	(45.7)
1-1/4	1.734	(44.0)	1.24	(31.5)	1.38	(35.1)	2.31	(58.7)

[a] A plus tolerance of 0.031 in (0.79 mm) and a minus tolerance of 0.015 in (0.38 mm) applies to the knockout diameter. Knockout diameters are measured other than at points where a tab remains after removal of knockout.

28.6 A wiring compartment with pig-tail leads used for the connection of field splices shall have the minimum volume specified in Table 28.2 for each conductor that terminates inside the compartment.

Table 28.2
Minimum volume for each conductor

Size of conductor		Minimum volume within wiring compartment	
AWG	(mm^2)	in^3	(cm^3)
18	(0.82)	0.5	(8.2)
16	(1.3)	0.6	(9.8)
14	(2.1)	0.75	(12.3)
12	(3.3)	1.0	(16.4)
10	(5.3)	1.7	(27.9)

28.7 The calculation for minimum volume in Table 28.2 shall include supply conductors, lampholder conductors, and any other insulated conductor. Uninsulated grounding or bonding conductors shall not be counted.

28.8 A surface mounted power unit exceeding 25 lb (11.34 kg) in weight and intended to be mounted over an outlet box shall be provided with an opening enabling access to the supply wiring splices without removing the unit from the mounting surface.

28.9 A recessed mounted power unit shall provide accessibility to the supply connections from the room side of the product.

Exception: The connections are capable of being accessible from behind the unit when marked in accordance with 48.5.5.

28.10 The power supply cord provided with an exposed bare conductor type power unit shall be junior hard or hard usage cord such as Type SJ, SJO, SJT, SJTO, S, SO, ST, or STO.

28.11 The attachment plug shall be rated in accordance with the power unit and shall comply with the Standard for Attachment Plugs and Receptacles, UL 498. When the power unit is required to be grounded, the plug shall be a grounding type; otherwise, the plug shall be a polarized parallel-blade type.

28.12 Flexible cord shall be provided with a strain relief means complying with Strain Relief for Flexible Cord Test, Section 41.

29 Secondary Connections

29.1 A power unit shall be provided with a means of connection for each output circuit in accordance with 28.1.

Exception No. 1: A Class 2 power unit is permitted to provide a means of connection suitable for power limited cable such as CL2, CL3, CAT5 (for a POE-enabled power unit), or equivalent.

Exception No. 2: The wiring means for a power unit intended for an exposed bare or an insulated conductor system shall comply with Exposed Bare and Insulated Conductors, Section 30.

29.2 For a Class 2 lighting system employing an interconnecting wiring system that is included as part of the system, the wiring method is permitted to be other than specified in 29.1, provided the wiring complies with Conductors and Cords, Section 15 and 28.2.

29.3 An exposed bare conductor power unit shall be provided with an output connection means which provides an electrically and mechanically secure connection for the low voltage exposed bare conductors.

29.4 Connectors with insulation-piercing terminals shall comply with the Insulation-Piercing Terminal Temperature Test, Section 45.

30 Exposed Bare and Insulated Conductors

30.1 The low voltage exposed conductors shall be one of the following:

a) Connected to an exposed bare conductor type power unit that is provided with integral protection against inadvertent shorting and overloading as specified in 19.5;

b) Connected to a Class 2 power unit and tested for compliance with Section 38A;

c) Provided with an insulating material that complies with the Insulated Conductor Dielectric Withstand Test, Section 43 and intended for mounting at least 7 ft (2.2 m) above the floor in accordance with 49.4(h); or

d) Provided with an insulating material that complies with Enclosure, Section 9.

30.2 For exposed bare conductor lighting systems, all low voltage current-carrying parts that extend through or are located behind a wall or ceiling surface after installation shall be enclosed in material that complies with Enclosure, Section 9.

30.3 Conductors that can be flexed after installation, including during repositioning or relamping of the luminaire, shall be stranded, secured in a manner that prevents cutting of or abrasion, and reliably spaced apart so that current-carrying parts of opposite polarity are not inadvertently shorted.

30.4 When the low voltage exposed secondary conductors are stranded, the supply connection means shall be such that loose strands are minimized.

30.5 All connections shall be electrically and mechanically secure. Connections that rely upon user adjustments made without the use of tools shall be tested in accordance with Loose Luminaire/Connection Test, Section 44.

31 Mounting Means

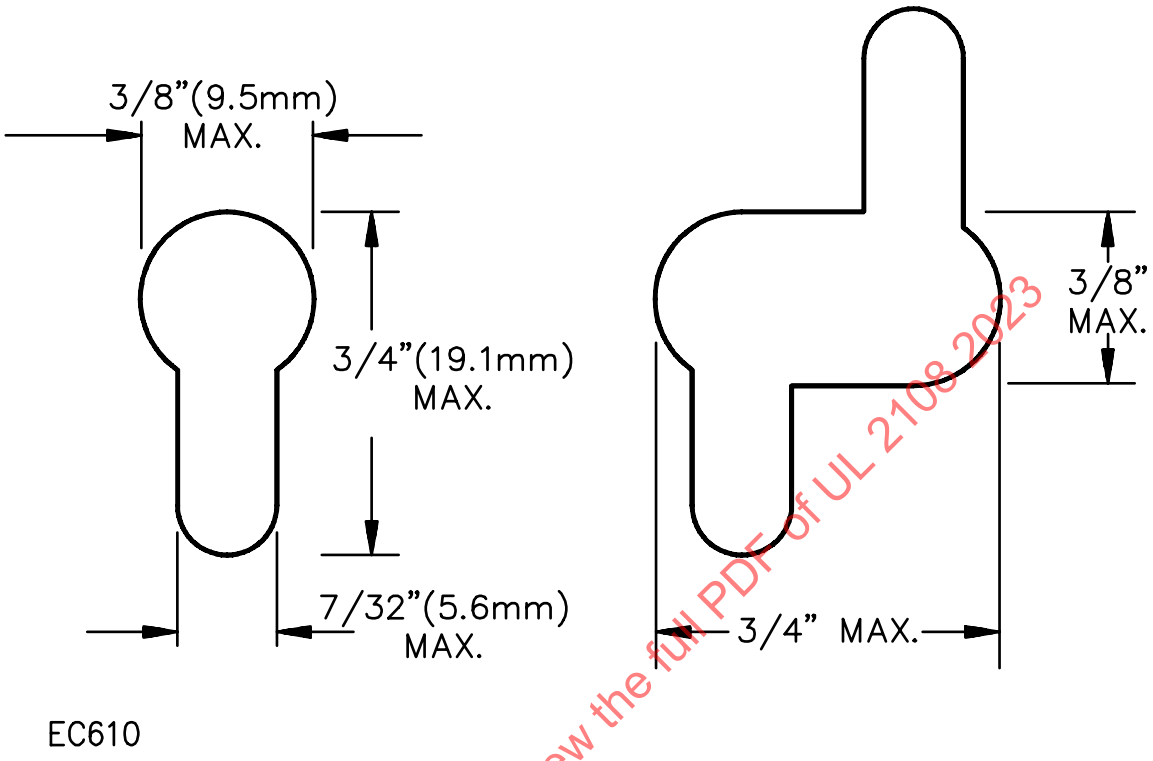
31.1 Power units and exposed bare conductor lighting systems, which are intended to be mounted to a suspended ceiling and exceed 50 lb (22.7 kg), including lamps, shall be provided with a means of support that is independent of the ceiling support unless otherwise specified by the installation instructions.

31.2 A power unit designed for surface mounting on a wall or ceiling shall have a maximum of five open mounting holes or keyhole slots in the back enclosure facing the mounting surface. A unit of this type is also able to have two such holes in addition for each additional 24 in (610 mm) of length in excess of 50 in (1.27 m).

31.3 The maximum mounting hole size specified in 31.2 shall not be larger in size than 1/4 by 1/2 in (6.4 by 12.7 mm), or 0.40 in (10.2 mm) in diameter. The keyhole slots shall not exceed the dimensions shown in Figure 31.1.

Figure 31.1

Keyhole slot/joined keyhole slot



31.4 A recessed power unit shall be provided with means for mounting suitable for holding the power unit in place under the expected conditions of use. The mounting means for a recessed power unit that weighs more than 2.2 lbs (1 kg) shall include hanger bars for mounting between wood joists, a plaster frame, ring, brackets, or the equivalent for direct attachment of the power unit to the building.

31.5 Exposed bare conductor lighting systems shall have all necessary mounting hardware provided for securing the system to the building structure. The mounting means shall comply with the Mounting Means Test, Section 42.

31.6 Power units intended for rack mounting and weighing more than 15.4 lb (7 kg) shall additionally comply with the applicable requirements of UL 60950-1, Annex DD.

PERFORMANCE

32 General

32.1 The test voltages used for the following tests described in Sections 33 – 36, 38, 39, and 44 shall be as specified in Table 32.1.

Table 32.1
Test voltages

Voltage rating[a]	Test voltage
110 – 125	120
220 – 240	240
254 – 277	277
440 – 480	480
560 – 600	600

[a] Other voltages not shown in these ranges shall be tested at the marked rating.

32.2 Branch circuit wiring supplying equipment under test shall be protected with a 20 A circuit breaker or fuse.

32.3 Where a test indicates a load or a resistive load, the load is to be a lamp load, a resistive load, or a combination of the two.

32.4 A Class 2 power unit is not required to be subjected to the tests described in 33.2 and Sections 36 – 39.

32.5 Where cheesecloth is specified as a fire indicator, it shall be untreated cotton cloth running 14 – 15 yd^2/lb (26 – 28 m^2/kg) and for any square inch, a count of 32 threads in one direction and 28 in the other direction.

33 Input and Output Tests

33.1 Input test

33.1.1 While connected to the nominal output load and to the rated primary voltage, the measured input current of the power unit shall not exceed rated input by more than 10%. The current measurement shall be made when the power unit is in a heated condition.

33.2 Maximum output test

33.2.1 With the power unit connected to rated input voltage, the measured open circuit secondary voltage of each circuit shall not exceed the risk of electric shock voltage.

33.2.2 The power unit is to be operated with nominal output load until constant temperatures (see 34.1.3) are achieved. The load is to be adjusted to the maximum it can sustain, up to 33.75 A. If the output can be sustained above 25A, the protective device shall operate within 1 h.

34 Normal Temperature Test

34.1 General

34.1.1 Low voltage lighting systems and components shall be tested as described in this Section and shall not attain a temperature at any point greater than indicated in Table 34.1.

34.1.2 The test is to be conducted at an ambient temperature of 25 ±5°C (77 ±9°F), unless the product instructions, per 49.3, specify a higher ambient in which case the test shall be conducted at the highest specified ambient ±5°C (±9°F). The ambient temperature is to be measured by means of a thermocouple immersed in a bath of mineral oil in a glass container, or other means equivalently immune to air

turbulence or convection currents. Final temperatures per 34.1.3 are to be normalized to 25°C (41°F) (or the marked maximum ambient), to determine compliance with Table 34.1.

34.1.3 Temperature readings to determine compliance with Table 34.1 are to be obtained by thermocouples. A temperature is determined to be constant when:

a) The test has been running for a minimum of 7.5 h; or

b) The test has been running for a minimum of 3 h and three successive readings taken at 15 min intervals are within 1°C (34°F) of one another and are not rising.

34.1.4 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). It is standard practice to employ thermocouples consisting of 30 AWG iron and constantan wires and a potentiometer-type instrument; and such equipment is to be used whenever reference temperature measurements by thermocouples are required. The thermocouple wires are to conform with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in ASTM E230/E230M.

Table 34.1
Maximum temperature

Component location	°C	(°F)
All Products		
1. Point of connection of supply wires	a	a
2. Lampholder body of thermosetting material (phenolic, urea, and the like)[b]	150	(302)
3. Coil of open coil type device, (ballasts or transformers) employing Class 105 insulation systems[h]:		
Thermocouple method	90	(194)
Change of resistance method	100	(212)
4. Capacitors[b]		
a. Electrolytic	65	(149)
b. Other types	90	(194)
5. Fuse	90	(194)
6. Copper conductor (bare or insulated) without a nickel coating or equivalent protection	150	(302)
7. Copper conductor plated with a nickel coating or equivalent protection	250	(482)
8. Termination of copper conductor and pressure terminal connectors without a nickel coating or equivalent protection	150	(302)
9. Lampholder screw shell, center contact, or other connecting device of aluminum or unplated copper	200	(392)
10 A nickel alloy current-carrying parts of other than a screwshell lampholder	315	(599)
11. Polymeric material used for enclosure or structural parts	c	c
12. Surface to which a marking label is attached	d	d
13. Wire or cord	e	e
14. Points of product support[f]	90	(194)
15. Electrical insulating materials[b]:		
Phenolic	150	(302)
Silicone rubber (not stressed)	200	(392)
Silicone rubber (compressed)	170	(338)

Table 34.1 Continued on Next Page

Table 34.1 Continued

Component location	°C	(°F)
Neoprene rubber (dry locations)	90	(194)
Neoprene rubber (oil or wet locations)	60	(140)
Rubber (ordinary)	60	(140)
Melamine	130	(266)
Nylon (polyamide)	105	(221)
Paper, wood, ordinary fiber	90	(194)
Urea	100	(212)
Varnished cloth insulation	85	(185)
Vulcanized fiber	90	(194)
16. Non-electrical insulating materials[b]:		
Silicone rubber	230	(446)
EPDM	90	(194)
Neoprene rubber	90	(194)
Rubber (ordinary)	70	(158)
Paper, wood, cork, or other fibrous material	90	(194)
Polyethylene	60	(140)
PVC	60	(140)
Acrylic	65	(149)
Polycarbonate	75	(167)
Non-thermosetting sealing compound	Rated	Rated
Recessed Mounted		
17. Metal of recessed housing (“Type Non-IC”)	150	(302)
18. Test box for recessed product (“Type Non-IC”)	90	(194)
19. Screen, shield, or recessed housing in contact with insulation (“Type IC”)	90	(194)
Cabinet Mounted or Storage Space of Clothes Closet		
20. Product housing	90	(194)
21. Test box for cabinet mounted	90	(194)
Exposed conductors		
22. Conductors (exposed insulated or exposed bare)	90	(194)

[a] Temperature shall not be greater than 200°C (392°F). The temperature is also limited by the marking requirement in 48.2.4 and Table 48.3.

[b] These limitations do not apply to compounds or components that have been investigated and found usable for a higher temperature.

[c] The investigation of a polymeric material shall comply with the requirements in 9.4.

[d] The maximum temperature is the temperature rating of a label that is used as a Form A marking as specified in Table 48.1.

[e] The maximum temperature is the temperature rating of the wire or cord used.

[f] The maximum temperature is 150°C (302°F) when a ceiling-mounted or recessed mounted product is marked in accordance with 48.3.2 or 48.5.6 to restrict its use to surfaces of noncombustible construction or when marked in accordance with 48.5.3 to restrict it to use in poured concrete.

[g] When the insulation system is rated for higher than 105°C (221°F), refer to the coil temperature limits in UL 1598.

34.1.5 A thermocouple junction and the adjacent thermocouple lead wire are to be held securely in thermal contact with the surface of the material of which the temperature is being measured, and are to be placed at locations of the hottest accessible parts.

34.1.6 Specific conditions for testing are indicated in 34.2 for power units. Additional conditions for the performance of normal temperature tests are as indicated in 34.3.1 for surface mounted products, 34.3.2 for recessed products, 34.3.3 for cabinet mounted products, and 34.4 for open devices.

34.1.7 *Deleted*

34.1.8 A part designed to be adjustable by the user shall be positioned or adjusted to result in maximum heating of the unit or mounting surface.

34.1.9 *Deleted*

34.1.10 When a product utilizes a polymeric part required by this standard (such as a thermoplastic enclosure, watershield, lens, or diffuser), temperatures are to be measured by placing one or more thermocouples in contact with the part in such a manner that the thermocouple is wedged between the part and any metallic material or other source of conducted heat. For a source of radiated or convected heat, thermocouples are to be inserted from the outside surface through holes drilled in the polymeric material, such that the thermocouple tips are located in the plane of the inside surface and are sealed in place with fuller's earth and sodium silicate (waterglass).

34.2 Power units

34.2.1 The power unit shall be mounted in accordance with the manufacturer's instructions.

34.2.2 The power unit shall be operated with nominal output load at rated input voltage and frequency. If there is more than one supply wire connection opening, the connection location that will generate the highest supply wire temperatures shall be used.

34.2.3 A transformer or magnetic ballast power unit shall be:

a) Tested with a 2-V dc offset potential shall be applied to the power unit input voltage. The 2-V dc offset potential is able to be obtained by using any usable means. The 2-V dc bias is to be measured on the switched ac input waveform by a dc volt meter having a frequency damped response in the range of 0 – 120 Hz;

b) Tested with a specific dimmer and marked per 48.2.8A; or

c) Marked in accordance with 48.2.8.

34.3 Additional test conditions

34.3.1 Surface mounted

34.3.1.1 A surface mounted product shall be installed as required and subjected to the Normal Temperature Tests – Surface ceiling luminaire or Surface wall luminaire, as specified in UL 1598, Clauses (15.2), Surface ceiling luminaires or (15.3), Surface wall luminaires.

34.3.1.2 A ceiling mounted product shall be tested on an insulated test ceiling.

Exception: When the product is for use only on a concrete or steel surface, or on a surface made of another identified noncombustible material, and is marked as described in 48.3.2, the test ceiling is not to be filled with insulation.

34.3.1.3 *Deleted*

34.3.1.4 A product that, from its appearance, is capable of being used either on a ceiling or on a wall, shall be tested as a ceiling-mounted unit.

Exception: A product marked for wall mounting as specified in 48.3.1 shall be tested as a wall-mounted unit.

34.3.2 Recessed mounted

34.3.2.1 A recessed mounted product marked “Type Non IC Recessed” in accordance with 48.5.2 shall be installed as required and subjected to the Normal Temperature Test – Type Non-IC recessed luminaire (not intended for thermal insulation contact) as specified in UL 1598, Clause 15.5. A recessed mounted luminaire marked for specific installation spacings in accordance with 67.3.5 shall instead be installed and tested as specified in UL 1598 Clause 15.6.

34.3.2.2 A recessed mounted product marked “Type IC Recessed” in accordance with 48.5.1 shall be installed as required and subjected to the Normal Temperature Test – Type IC recessed luminaire (intended for thermal insulation contact) as specified in UL 1598, Clause 15.7.

34.3.2.3 When a recessed product is subjected to the normal temperature test using the test conditions described in 34.3.2.1 and 34.3.2.2, the unit complies when the temperatures attained:

a) Do not exceed the values indicated in Table 34.1; and

b) Do not result in the functioning of the thermal protective device.

34.3.3 Cabinet mounted

34.3.3.1 A product that is intended for installation into an open or enclosed cabinet is to be mounted in the test box for portable cabinet lights described in UL 153.

34.3.3.2 The test box specified in 34.3.3.1 shall use the manufacturer's specified spacing as described in 48.4.3 and, when marked as in 48.4.4 for open top use, shall be tested with the top of the box open. The minimum inside box dimensions shall not be less than 12 in (305 mm).

34.3.4 Under-cabinet or shelf mounted

34.3.4.1 A product intended for installation under a shelf or cabinet is to be attached to a sheet of 1/2 in (12.7 mm) thick plywood and mounted inside the test alcove for surface-mounted under-cabinet luminaires described in UL 1598, so the product touches two walls and the top of the alcove.

34.4 Open devices

34.4.1 An open device shall be installed and mounted in accordance with its installation instructions, per 50A.1. Non-thermally conductive materials (such as wood or plastic) shall surround the device (including for the mounting surface, unless specifically precluded by the instructions) at the minimum spacings noted in the instructions.

35 Abnormal Recessed Temperature Test

35.1 A recessed power unit marked “Type Non-IC Recessed” in accordance with 48.5.2 shall be installed as required and subjected to the Abnormal Temperature Test – Type Non-IC recessed luminaire (not intended for thermal insulation contact) as specified in UL 1598, Clause 16.2.

35.2 When a recessed mounted power unit or luminaire marked “Type Non-IC Recessed” is subjected to the Abnormal Temperature Test using the test conditions described in 35.1, the unit complies when the thermal protector:

a) Operates with 3 h and no part of the unit in contact with thermal insulation or the test box exceeds 160°C (320°F); or

b) Does not operate within 3 h and the temperature limits specified in Table 34.1 are not exceeded during the test. Any part of the unit in contact with thermal insulation or the test box shall not exceed 90°C (194°F). The test shall be terminated after 7.5 h.

36 Overload Test

36.1 A power unit shall comply with the overload test described in this Section.

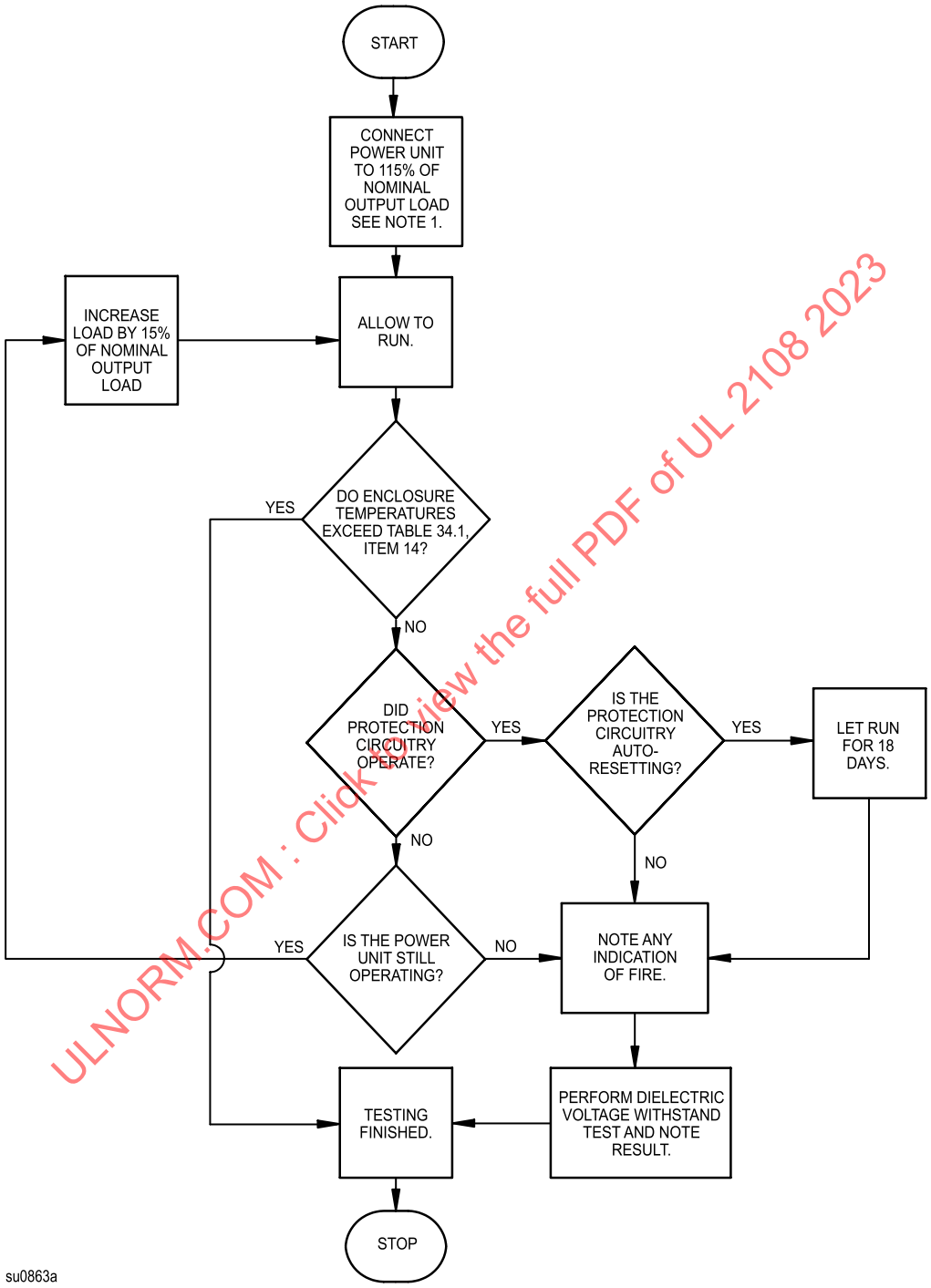
36.2 The power unit is to be mounted in accordance with the manufacturer's instructions and on a test surface or in a test box as specified in 34.3 as applicable. A thin layer of cotton cheesecloth is to be placed around the power unit. The rated load plus 15% of the rated secondary wattage is to be connected to the unit. If a 15% overload cannot be sustained, the highest stable overload condition shall be the starting point for the test.

Exception: A recessed mounted power unit marked “Type IC Recessed” shall be installed in a test box filled with 8-1/2 in (216 mm) insulation instead of the cotton.

36.3 The power unit is to be operated according to the procedure shown in Figure 36.1.

Figure 36.1

Overload test flow chart



Note – Refer to 36.2

36.4 The results meet the intent of the requirement when there is no ignition of the cotton, the unit complies with the Dielectric Voltage Withstand Test specified in Section 37, and the outside of the enclosure that contacts a supporting surface complies with Table 34.1, item 14.

Exception: A recessed power unit shall not exceed 160°C (320°F) on the enclosure if the protector operates within 3 h, or 90°C (194°F) after 3 h of operation.

37 Dielectric Voltage Withstand Test

37.1 The power unit shall successfully withstand for a period of 1 min a voltage of:

a) 1000 V ac rms plus twice the rated input voltage between the primary circuit and the exposed grounded dead metal of the enclosure; and

b) 2500 V ac rms between the primary circuit and the isolated secondary circuit.

The results meet the intent of the requirement when there is no dielectric breakdown.

Exception: A dc potential is permitted at 1.414 times the specified ac potential.

NOTE: Surge protective devices bridging the circuit locations under test may be removed for this test.

37.2 To determine if equipment complies with 37.1, the applied potential is to be increased from zero until the required test value is reached, and is to be held at that value for 1 min. The applied potential is to be increased at a uniform rate, as rapidly as consistent with its value being correctly indicated by the voltmeter.

37.3 The test equipment transformer shall by 500 VA or greater, or the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

38 Exposed Bare Conductor Abnormal Operation Test

38.1 The power unit for an exposed bare conductor type lighting system is to be mounted in accordance with the manufacturer's instructions. The maximum rated length, or thirty 30 ft (9.14 m), whichever is less, of the exposed bare conductors is to be connected to the output of the power unit. A representative luminaire load equal to 80% of the power unit rating is to be connected to the exposed bare conductors.

38.2 The luminaire load specified in 38.1 is to consist of a number of luminaires, which are equally spaced along the length of the exposed bare conductors. The wattage of the individual luminaires shall be their rated lamp wattage, except that the luminaire located farthest from the power unit may have a lesser lamp wattage so that the sum of the individual luminaire wattage ratings are equal to 80% of the power unit rating.

38.3 The power unit is to be connected to the rated supply voltage. The test-shorting fixture as shown in Figure 38.1 is to be connected to the uninsulated exposed bare conductor connectors with clips (or a modified system connector) at the following locations and power conditions:

a) With the power unit de-energized, the de-energized test-shorting fixture is to be connected to the exposed bare conductors at a location closest to the power unit. The power unit is then to be energized. Afterwards the test-shorting fixture is to be energized to shunt the test shorting wire across the exposed bare conductors. The results shall be evaluated per 38.6 and 38.7.

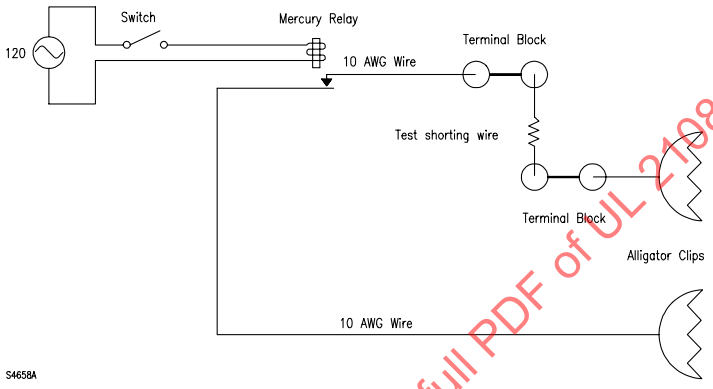
b) Same as (a) except the test-shorting fixture is to be energized prior to energizing the power unit.

c) With the power unit de-energized, the de-energized test- shorting fixture is to be connected to the exposed bare conductors at a location farthest from the power unit, or thirty 30 ft (9.14 m), whichever is less. The power unit is then to be energized. Afterwards the test-shorting fixture is to be energized to shunt the test shorting wire across the exposed bare conductors. The results shall be evaluated per 38.6 and 38.7.

d) Same as (c) except the test-shorting fixture is to be energized prior to energizing the power unit.

Figure 38.1

Test shorting fixture



NOTES:

(a) Mercury relay shall be rated not less than 60 A.

(b) Alligator clips shall be rated not less than 40 A.

(c) Testing shorting wire is 22 AWG (0.32 mm^2) solid tin plated copper 8 in (203 mm) in length.

(d) With relay contacts closed and test shorting wire installed, dc resistance through the circuit from one alligator clip jaw to the jaw of the other alligator clip shall not exceed 0.1 Ω. All current carrying parts shall be at 25 ±5°C (77 ±9°F) during measurement.

38.4 The test shorting wire specified in 38.3 and shown in Figure 38.1 consists of an 8 in (203 mm) long, 22 AWG (0.32 mm^2) tinned solid copper wire, which is supported horizontally and spaced at least 1 in (25.4 mm) away from the supporting surface of the test-shorting fixture.

38.5 Unless marked “Not for use with a dimmer” in accordance with 48.2.8, the tests in 38.1 – 38.3 shall be repeated with the power unit connected to a variable AC supply adjusted to 50% of rated supply voltage.

38.6 Each test condition of 38.3 shall be conducted three times, each with a new test shorting wire, until either:

a) The test shorting wire melts through within 1 min;

b) The test shorting wire does not melt though and the power to the exposed bare conductor is de-energized within 1 min; or

c) The power to the exposed bare conductor is not de-energized within 1 min.

38.7 The test results of 38.6(a) indicate non-compliance with the requirements. The test results of 38.6(b) indicates compliance with the requirements.

38.8 If test condition of 38.6(c) occurs, the test conditions in 38.3 shall be repeated with a thin layer of cotton cheesecloth draped over the test wire. Each test condition of 38.3 shall be conducted three times, each with a new test shorting wire. If the protective device does not de-energize the power unit or the test shorting wire does not melt through within 1 min, the test shall be terminated after 1 min for each test condition.

38.9 The test results of 38.8 meet the intent of the requirement when the cotton does not ignite.

38A Class 2-Supplied Exposed Bare Conductor Abnormal Operation Test

38A.1 An exposed bare conductor system supplied by a class 2 power source, per 30.1(b), shall comply with this section.

38A.2 A 22 AWG (0.32 mm^2) tinned solid copper wire shall be connected to short across external surfaces intended to carry current. The wire can be connected to each side of the circuit by any convenient means (alligator clips, solder, etc.) provided that good conduction is established. The luminaire shall then be connected to a rated source of supply and energized.

38A.3 The output from the power unit shall automatically halt within 10 seconds, with no melting of the shorting wire, and shall not re-energize prior to removal of the shorting conductor. This test shall be repeated two additional times, with similar results.

38A.4 The test of 38A.2 shall then be repeated but with the luminaire energized prior to applying the shorting conductor. This may require insertion of a separate switch element between the shorting conductor and one side of the circuit. Compliance with 38A.3 shall be observed, for three trials.

39 Component Fault Test

39.1 A circuit employing an electronic component that requires a component fault test in accordance with 20.4 shall be tested in accordance with 39.2 – 39.7. Compliance criteria is described in 39.8.

39.2 A circuit involving a capacitor, rectifier, transistor, or similar component involving a risk of fire or electric shock shall be subjected to a component fault test, with the component opened or shorted in accordance with Component Fault Test, Section 39.

39.3 For the test described in 39.2, only one component and fault condition is to be conducted per each test.

39.4 The power unit is to be placed on a knot-free softwood surface covered with tissue paper. Any dead metal is to be connected through a 3 A nonrenewable fuse to either:

a) Earth ground when the unit is provided with a grounding type attachment plug; or

b) The neutral conductor when not provided with a grounding type attachment plug.

39.5 The unit is to be loosely draped with a single layer of cheesecloth and operated continuously.

39.6 The test is to be operated until ultimate conditions occur but not exceeding 7 h.

39.7 The tissue paper used in the abnormal test is to be untreated white paper commonly used for gift-wrapping.

39.8 There shall be no:

a) Emission of flame or molten metal;

b) Combustion, glowing or flaming or disintegration of the material on which the unit is resting or of material placed on or near the unit;

c) Exposure of parts involving a risk of electric shock; or

d) Dielectric breakdown when subjected to the Dielectric Voltage Withstand Test, Section 37, during any of these tests.

40 Grounding Continuity Test

40.1 To determine compliance with 17.4 and 27.3, each power unit provided with a grounding means shall be tested for grounding continuity between the grounding means and the conductive part required to be grounded.

40.2 An ohmmeter or other indicating instrument is to be used. When results do not comply with the requirement, either an alternating or direct current of at least 25 A from a power supply of not more than 12 V is to be passed from the point of connection of the equipment grounding means to the part required to be grounded, and the resulting drop in voltage is to be measured between the two points. The resistance in ohms is then to be calculated by dividing the drop in potential (in volts) by the current (in amperes). The results meet the intent of the requirement when the resistance does not exceed 0.1 Ω.

41 Strain Relief for Flexible Cord Test

41.1 A strain relief device is to be tested by the application of a 35 lb (156 N) pulling force on the cord for 1 min.

41.2 The conductors are to be severed immediately adjacent to the terminals or splices. The pull is to be applied to the cord or wire in a direction perpendicular to the plane of entrance to the product.

41.3 There shall be no movement of the cord more than 1/16 in (1.6 mm) from the point where it is severed.

42 Mounting Means Test

42.1 Tension loading

42.1.1 A representative sample of mounting hardware used to apply or maintain tension on flexible cables of an exposed bare conductor lighting system shall be mounted to a wood surface with a short section of cable installed at each intended location. A pulling force of 111.25 N (25 lb) shall be applied for 5 min simultaneously to each cable in the direction of the tension force.

42.2 Gravity loading

42.2.1 Mounting hardware provided with rigid track type of exposed bare conductor lighting systems shall be tested as follows:

a) A representative sample shall be mounted to the center of a 4-ft length of track;

b) The track for ceiling mount systems shall be supported at both ends (horizontal) and oriented so the mounting hardware is located on the underside of the track. The track for wall mount systems shall be oriented and supported as intended; and

c) A 2.3 kg (5 lb) load in the direction of gravity shall be applied for 5 min to the mounting hardware sample at the point where the fasteners holding the mounting hardware to the building surface would be located.

42.3 Test Results

42.3.1 Test results are acceptable when:

a) The exposed bare conductors do not pull free from the building surface; and

b) There is no reduction of spacings below values specified in Electrical Spacings, Section 23.

43 Insulated Conductor Dielectric Withstand Test

43.1 A low voltage exposed insulated conductor complying with the requirements of 30.1(c) shall be subjected to this test and shall not have any indication of dielectric breakdown.

43.2 The exposed insulated conductor is to be wrapped in metal foil. A potential of 500 V is to be applied for 1 min between the foil and conductive parts of the conductor.

43.3 The test equipment is to be the same as described in Dielectric Voltage Withstand Test, Section 37.

44 Loose Luminaire/Connection Test

44.1 This test shall be conducted for any connections that rely upon user adjustments made without the use of tools in accordance with 30.5. The general test setup shall be the same as described in 34.2 for the Normal Temperature Test, except that any user connections shall be made in the loosest condition possible without jeopardizing the integrity of the assembly.

44.2 The test is to be operated for 7-1/2 h. A luminaire that is able to be energized while resting on the low voltage bare supply conductors shall be tested in that configuration.

44.3 The system, including the loose connections, shall remain within the temperature limits of Table 34.1.

45 Insulation-Piercing Terminal Temperature Test

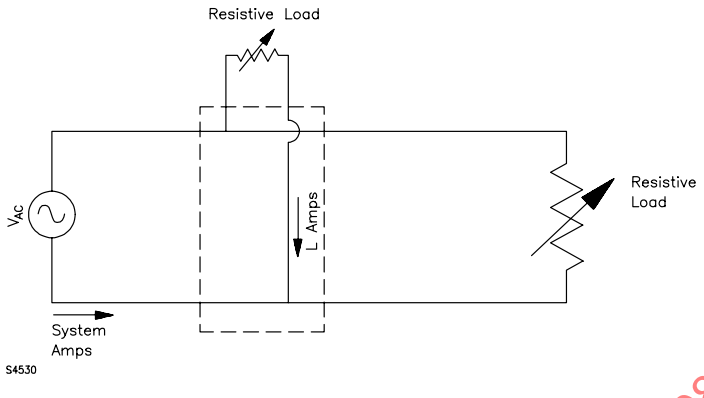
45.1 As specified in 29.4, connectors with insulation-piercing terminals shall be tested in accordance with 45.2 – 45.6.

45.2 Thermocouples are to be placed on the wire insulation as close to the terminal connections as construction permits. Thermocouples are to be placed in the same location on six previously untested connectors.

45.3 The connectors are to be installed in accordance with the installation instructions in the position and under the conditions that to cause maximum temperatures to be reached. The test is to be performed at rated current installed as intended. Each connector shall have its own load as obtained by use of an adjustable resistor so that the connector is being subjected to the current from the supply to the luminaire load. See Figure 45.1 and Figure 45.2.

Figure 45.1

Cable-to-luminaire test circuit



Notes:

1. Luminaire amps shall be at the maximum current based on the lamp wattage (for incandescent lamps), the power supply output (if constant current), or based on the size of the conductor marked on the connector.

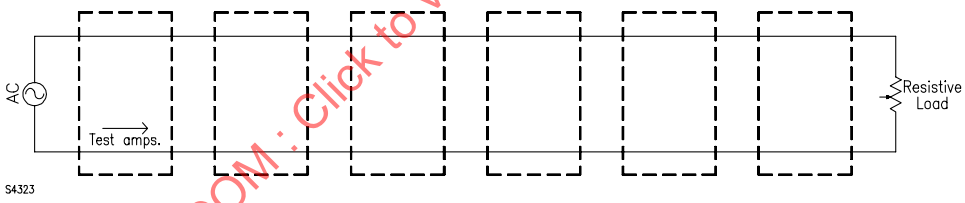
2. System amps shall be the current based on the size of the conductor, but shall not exceed 25 A. It is produced by adjusting the resistive load to obtain the system amps.

3. The power source shall be located within 1 ft of the connector under test, unless otherwise specified in the installation instructions.

4. Minimum supply conductor length (from supply source to source load) shall be 25 ft.

Figure 45.2

Cable-to-cable test circuit



Notes:

1. Test amps is determined by the size of the cable, and shall not exceed 25 A. It is produced by adjusting the resistive load to obtain the correct current.

2. The distance between connectors shall not be less than 1 ft in order to reduce the risk of heat from one connector effecting another.

3. Minimum supply conductor length (from source to source load) shall be 25 ft.

45.4 Six previously untested connectors are to be assembled to conductors of the size and type for which they are intended. Multiple tests are required if the connector is designed for several types of wire sizes or types. The connectors are to be connected to the test load. For “cable-to-cable” connectors, the test circuit has capability of consisting of all six connectors in series with one power source and one load. For “cable-to-luminaire” connectors, the test circuit has capability of consisting of the six connectors each connected to its lamp load and the main secondary load with one power source. The temperature of the insulation piercing terminal connections is to be monitored continuously. The connectors are to be operated for a period of 7 h and the temperature of the insulation piercing terminal connections recorded.

Exception: When multiple tests are to be conducted, testing the maximum and minimum of a particular conductor type represents intermediate wire gauge sizes.

45.5 The same six connectors are to be cycled for a total of 180 cycles at a rate of 3-1/2 h on and 1/2 h off. The temperatures of the insulation piercing terminal connections are to be monitored continuously throughout the 180 cycle period. After the last cycle, the connectors are to be energized for a period of 7 h, after which temperatures are again to be measured. The off cycle time is able to be extended for the convenience of measurement.

Exception: Connectors in class 2 circuits are subject to only 30 cycles prior to the 7 hour operational period.

45.6 Throughout the test described in 45.5, the maximum temperature of the insulation piercing terminal connections on each connector shall not be more than 30°C (54°F) higher than the temperatures measured on the same connector in 45.4. In no case shall the temperatures of the insulating piercing terminals exceed 90°C (194°F).

MANUFACTURING AND PRODUCTION TESTS

46 Dielectric Voltage Withstand Test

Section 46 deleted

47 Continuity of Grounding Connection Test

Section 47 deleted

MARKING

48 Details

48.1 General

48.1.1 Markings required by this section shall be legible, be one of the types designated in Table 48.1, and be located as designated in Table 48.2.

Table 48.1
Form designations for type of marking

Form letter of marking	Type
A	Permanent – Paint-stenciled, die-stamped, indelibly printed lettering, or indelibly printed pressure sensitive label.[a]
B	Temporary – Pressure-sensitive label, decalcomania transfer, paper label, paint, ink, or die stamped lettering.[b]
C	Instructions – Tie-on tag, stuffer sheet or equivalent[c,d]

[a] Pressure sensitive labels shall comply with the requirements in UL 969. Flag, tag, and wrap-around labels, applied per 48.1.10, shall comply with UL 969A and have a limited slippage rating.

[b] Form A markings are also able to be used.

[c] Forms A and B markings are also able to be used.

[d] Instructions are permitted to be abbreviated if they include a website reference where the full set of instructions can be accessed without need for password or registration. See 48.1.11.

Table 48.2
Form designations for locations of markings

Form number of marking	Location of markings[a]
1	Visible after installation on an exterior surface or by removal of a part using an ordinary tool
2	Visible during relamping
3	Visible during installation
4	On the smallest unit packaging carton

[a] Form A markings of field-cuttable class 2 luminaires (strips or tapes) are to be repeated at intervals not exceeding the minimum cut length as specified in the installation instructions.

48.1.2 When the words of a particular marking are given within quotation marks in this standard, the actual wording must be used. Words between parenthesis are optional.

48.1.3 The minimum letter height for markings in Table 48.1 shall be 1/16 in (1.6 mm) unless a larger height is specified in the individual marking requirement.

48.1.4 A product that from its appearance is able to be mounted in more than one position, shall be marked in Form C3 to indicate its correct orientation, such as wall or ceiling.

48.1.5 *Deleted*

Table 48.3
Temperature markings

Temperature attained at point where power-supply wires are connected		Marked temperature	
°C	(°F)	°C	(°F)
61 – 75	(142 – 167)	75	(167)
76 – 85	(169 – 185)	85	(185)
86 –90	(187 – 194)	90	(194)

Table 48.3 Continued on Next Page

Table 48.3 Continued

Temperature attained at point where power-supply wires are connected		Marked temperature	
°C	(°F)	°C	(°F)
91 – 110	(196 – 230)	110[a]	(230)[a]
111 – 125	(232 – 257)	125[a]	(257)[a]
126 – 150	(259 – 302)	150[a]	(302)[a]
151 – 200	(304 – 392)	200[a]	(392)[a]

[a] See 48.2.4.

48.1.6 *Deleted*

48.1.7 *Deleted*

48.1.8 *Deleted*

48.1.9 A product intended for installation in air handling spaces (plenums) and complying with Section 11A is permitted to be marked “Suitable for Use In Air Handling Spaces” or “Suitable for Use in Other Environmental Air Space in Accordance with Section 300.22 (C) of the National Electrical Code.”

48.1.10 In accordance with Table 48.1 footnote (a), the following tag and flag markings are permitted:

a) A hang-type tag having a hole to permit securement to the cord by a plastic strap or equivalent. The strap shall not be removable without cutting.

b) A flag-type tag with the adhesive back. The tag is to be wrapped around and adhere to the cord. The ends of the tag are to adhere to each other and project as a flag.

48.1.11 In accordance with footnote (d) of Table 48.1, the full set of instructions are permitted to be on a publicly accessible web site if the stuffer sheet (or equivalent) includes a QR code or "See (specific URL inserted here) for instructions."

48.2 Power units

48.2.1 A power unit shall be marked in Form A1 with the:

a) Manufacturer's name;

b) Catalog or model number;

c) Electrical ratings; and

d) Date or other dating period of manufacture, not exceeding any three consecutive months.

48.2.2 The electrical ratings in 48.2.1 shall include the following:

a) Input voltage;

b) Input current;

c) Frequency;

d) Output voltage; and

e) Output current or wattage.

48.2.2.1 In regards to 48.2.2 (d) and (e), for a power unit with multiple outputs, the rating refers to the output for each output terminal, port, or set of lead wires. Where all such outputs, or groups of co-located outputs, have the same ratings, the markings can be consolidated provided that the relationship between the marking(s) and the outputs is visually clear.

48.2.2.2 For a power unit whose output can vary based on the connected load characteristics, the ratings identified under 48.2.2 (d) and (e) shall be the maximum available voltage (or current) and power available from that output.

48.2.3 The date of manufacture is able to be abbreviated or is able to be in a nationally recognized conventional code or in a code affirmed by the manufacturer, when the code:

a) Does not repeat in less than 10 years; and

b) Does not require reference to the production records of the manufacturer to determine when the product was manufactured.

48.2.4 When a permanently connected power unit attains a temperature of more than 60°C (140°F) in the supply compartment, the power unit shall be marked as follows "For supply connections use wire rated for at least ____°C (____°F)," in which the blanks are filled in with the temperatures specified in Table 48.3. Form B3.

48.2.5 A power unit marked for supply connections greater than 90°C (194°F) shall be marked "Not for use in dwellings." Form B4.

48.2.6 A power unit having a pressure wire terminal for the connection of an equipment grounding conductor shall be marked adjacent to the terminal or screw "GROUND," "GRND," "GND," or similar designation in Form B3. The symbol ⏚ (IEC Publication 417, Symbol 5019) is usable, and when used alone the symbol shall be defined in the installation instruction provided with the equipment.

48.2.7 When a replaceable fuse is provided, there shall be a marking located near the fuseholder that states "CAUTION: Disconnect power before replacing fuse. Replace only with same type _____ A, _____ V fuse." The blanks are to be filled in with the appropriate fuse ratings. The word 'CAUTION' shall be in minimum 3/32 in (2.4 mm) letter height. Form A1.

48.2.8 A transformer or magnetic ballast power unit not temperature tested with a 2-V dc offset or with a specific dimmer shall be marked in Form A3 with either (a) "Not for use with dimmers" or (b) "Dimmer, if used, must be a magnetic low-voltage dimmer". Equivalent wording shall be permitted.

48.2.8A A transformer or magnetic ballast power unit tested with a specific dimmer in accordance with 34.2.3(b) shall be marked in Form A3 to identify the dimmer manufacturer and catalog number.

48.2.9 An exposed bare conductor type power unit shipped separately from the luminaires shall be marked "For use with _____ low voltage lighting system only," where the blank spaces are to be filled in with the manufacturer's name and series designation. Form B3.

48.2.10 A power unit in which output is limited to Class 2 levels in accordance with 18.2 is permitted to be marked "Class 2."

48.2.11 A power unit whose output is limited to Class 2 levels in accordance with 18.2 (a), (b), or (c) is permitted to be marked "Suitable for Class 2 Wiring", or equivalent.

48.2.12 A product complying with the wet location requirements of Damp and Wet Locations, Section 13 is able to be marked “Suitable for Wet Locations”. Form A3.

48.2.13 A product complying with the damp location requirements of Damp and Wet Locations, Section 13 is able to be marked “Suitable for Damp Locations”, Form A3.

48.3 Wall and ceiling surface mount

48.3.1 A product complying with the Exception of 34.3.1.4 shall be marked “Wall” or “Wall only,” as applicable. Form B3.

48.3.2 A ceiling-mounted product tested on an uninsulated ceiling as described in the Exception of 34.3.1.2 shall be marked “Mount on _____ only.” The blank is to be filled with an identified noncombustible material (such as concrete or steel). Form B3.

48.4 Under-cabinet and cabinet mount

48.4.1 A cabinet-mounted product tested in the test box described in 34.3.3.2 shall be marked “For cabinet use only.” Form B3.

48.4.2 The marking in 48.4.1 includes under cabinet and surface mounting use, as applicable.

48.4.3 A cabinet-mounted product shall be marked “CAUTION” and the following or the equivalent: “To reduce the risk of fire, do not install closer than ____ inches to cabinet wall or in a compartment smaller than ____ inches by ____ inches by ____ inches.” The blanks are to be filled in with the parameters of the temperature test. The word ‘CAUTION’ shall be in minimum 3/32 in (2.4 mm) letter height. Form C.

Exception: The inclusion of metric dimensions is not prohibited.

48.4.4 A cabinet-mounted product intended only for use in a cabinet, where the cabinet is not enclosed at the top, shall be marked “Install only in cabinets where the top of the cabinet light housing is not enclosed” or “Install only in open top cabinets.” Form B1.

48.4.5 An under-cabinet or shelf-mounted product tested as described in 34.3.4.1 shall be marked “For under-cabinet mount,” or “For under-cabinet or shelf mount,” as applicable. Form B3.

48.4.6 An under-cabinet or shelf mounted product as marked in 48.4.5 shall not be provided with any information such as markings, instructions, or illustrations either on the carton or with the luminaire that implies or depicts an installation into an open or enclosed cabinet.

48.4.7 A cabinet-mounted product as marked in 48.4.1 shall not be provided with any information such as markings, instructions, or illustrations either on the carton or with the luminaire, that implies or depicts an installation into a ceiling.

48.5 Recessed mounting

48.5.1 A Type IC product shall be marked:

a) “Type IC Recessed” Form B3; and

b) “Notice – Blinking light may indicate improper lamp wattage or type (or other condition causing overheating),” Form A2, when provided with a thermal protective device; or

c) “Inherently Protected” when not provided with a thermal protective device. Form B3.

48.5.2 A Type Non-IC product shall be marked:

a) “Type Non-IC Recessed,” Form B3; and

b) “Warning – Risk of Fire. Do not install insulation within 3 in of unit sides or above unit in such a manner to entrap heat.” The word ‘Warning’ shall be in minimum 1/16 in (3.2 mm) letter height. Form B3.

c) “Notice – Thermally protected. Blinking light may indicate insulation too close to unit (or other condition causing overheating),” Form A2.

48.5.3 A product that is intended for poured concrete use only shall be marked “For use in concrete only.” Form B3.

48.5.4 A product that is intended for in-ground use only shall be marked “For in-ground installation only.” Form B3.

48.5.5 A product that complies with the Exception of 28.9 shall be marked “Access above ceiling required” or “Access behind wall required.” Form C.

48.5.6 A product that produces a temperature greater than 90°C (194°F), on a mounting surface shall be marked “Mount only on noncombustible surfaces.” Form B3.

48.5.7 Per 11.10, a product with a polymeric recessed housing shall be marked “Not for use in fire rated installations” in Form B3 or “For use in one and two family dwellings only”in Form C.

48.6 Pictograph type markings

48.6.1 A marking required elsewhere in this standard is able to be in the form of a pictograph or a combination of a pictograph and word(s).

INSTALLATION INSTRUCTIONS

49 Power Units

49.1 A power unit intended for use with multiple luminaires shall have installation instructions which provide information to the user on how to determine the number of luminaires and the lamp wattage to be used with the power unit.

49.2 An exposed bare conductor type power unit shipped separately from the luminaires shall include instructions “For use with _____ low voltage lighting system only,” where the blank spaces are to be filled in with the manufacturer's name and series designation.

49.3 Installation instructions shall be provided that include specific instructions for maximum ambient [if greater than 25°C (77°F), per 34.1.2], mounting, wiring, minimum wire size, grounding, and servicing. A maximum ambient, if specified, shall be in increments no smaller than 5°C (9°F) (e.g., 30°C, 35°C, 40°C, etc.). For exposed bare conductor type power units, the maximum intended length of the exposed bare conductors shall also be included.

49.4 Important safety instructions shall be provided with an exposed bare conductor type power unit which includes the following information:

IMPORTANT SAFETY INSTRUCTIONS

a) Read all instructions.

b) Do not conceal or extend exposed conductors through a building wall.

c) Do not install this system in wet locations.

d) To reduce the risk of fire and burns, do not install this lighting system where the exposed bare conductors can be shorted or contact any conductive materials.

e) To reduce the risk of fire and overheating, make sure all connections are tight.

f) Do not install any luminaire closer than 6 in (152 mm) from any curtain, or similar combustible materials.

g) Turn off electrical power before modifying the lighting system in any way.

h) [For low voltage exposed insulated conductor systems required by 30.1(c):] Do not install any part of this system less than 7 ft (2.2 m) above the floor.

SAVE THESE INSTRUCTIONS

49.5 The phrases “IMPORTANT SAFETY INSTRUCTIONS” and “SAVE THESE INSTRUCTIONS” in 49.2 shall be at least 3/16 in (4.8 mm) high. All other lettering shall be at least 1/16 in (1.6 mm) high.

50 Exposed Bare Conductors

50.1 Installation instructions shall be provided with the low voltage exposed bare conductors that include specific instructions for mounting and connection to the power unit.

50A Open Devices

50A.1 Installation instructions provided with an open device shall identify:

a) The minimum spacing requirements, if any, between the device and any combustible materials or other devices,

b) Suitable material types for housing the device, relative to fire containment, and

c) Whether the housing is permitted to have ventilation openings or other features relative to the environmental exposure of the device.

PART II – EXPOSED BARE CONDUCTOR LUMINAIRES, CLASS 2 LUMINAIRES, AND CLASS 2 COMPONENTS

GENERAL

51 General

51.1 These requirements apply to luminaires and components intended to be supplied by low voltage exposed bare conductors and to luminaires and components intended to be supplied by a Class 2 power unit.

NOTE: These requirements apply to both class 2 power and signal inputs. Where separate conductors are used for power and signal purposes, the circuit separation requirements of UL 8750 clause SF3.1 (including Exception No. 1, if applicable) are to be applied.

51.2 In addition to requirements specified in Part 2, luminaires shall also comply with the requirements in Part 1 of the standard as identified in Table 51.1.

Table 51.1
Part 1 requirements applicable to Part 2 luminaires

Section	Paragraph
General Construction	8.1 and 8.2
Recessed Housing	11.1 – 11.10
Equipment for use in Environmental Air-Handling Spaces	11A.1 – 11A.2
Corrosion Protection	12.1 and 12.2
Current Carrying Parts	14.1[a]
Conductors and Cords	15.1 – 15.3
Splices and Connections	16.1 and 16.2
Protective Devices	19.6
Switches[b]	21.2
Electrical Spacings	23.1 and 23.2
Electrical Barriers	24.1
Electrical Insulation	25.2
Exposed Bare Conductors	30.1 – 30.5

[a] Galvanized or stainless steel is also permitted. Aluminum is permitted for dry locations.

[b] Exposed bare conductor luminaires only.

51.3 A luminaire whose input and operating voltage does not exceed the limits for risk of electric shock under wet conditions, per 3.19, is permitted to be marked in accordance with 67.1.7.

Exception: The operating voltage is permitted to exceed the limits for risk of electric shock under wet conditions if the luminaire complies with the wet location construction and performance requirements of UL 1598.

NOTE: The input voltages within the scope of UL 2108 are different between dry/damp versus wet locations, to align with NEC Article 411 as cited in 1.1. A 48 Vdc (for example) luminaire in a dry or damp location is within the scope of UL 2108, but if installed in a wet location it is outside the scope of NEC 411. The luminaire is then within the scope of NEC 410 and must be evaluated in accordance with UL 1598.

51.4 A low voltage luminaire with a fluorescent light source shall comply with the additional requirements of Fluorescent Luminaires, Section 75.

CONSTRUCTION – MECHANICAL

52 General Construction

52.1 Rotation of a part of an assembly constructed for rotation shall be limited to no more than 360 degrees when damage to wiring or any other electrical part results from rotation in excess of 360 degrees.

Exception: A swivel lighting luminaire is able to be turned no more than 200 degrees in either direction for a total of 400 degrees.

53 Housing

53.1 A luminaire or component shall be provided with a housing that complies with 53.2 if metal or 53.3 if a polymeric material.

Exception: A luminaire or component is not required to have a housing if the internal components are otherwise provided with equivalent protection or comply with the Luminaire Component Fault Test, Section 66.

53.2 The minimum thickness for a metal housing of a luminaire shall be 0.016 in (0.41 mm).

Exception: This requirement does not apply to luminaires protected by power units complying with 30.1(a).

53.3 A housing formed of a polymeric material shall comply with the following:

a) Minimum flammability rating of V-0 for exposed bare conductor luminaires and HB for Class 2 luminaires and components;

b) Exposed bare conductor luminaires – Luminaire Drop Impact Test, Section 62;

c) Exposed bare conductor luminaires – mold stress evaluation per the air oven method in UL 746C; and

d) Mechanical with impact and electrical temperature index (RTI) of at least the temperature measured on the part during the normal temperature test.

Exception: When the temperature measured during the normal temperature test is less than 65°C (149°F), the enclosure is not required to comply with (d).

54 Mounting Means

54.1 A Class 2 surface mounted luminaire shall be provided with a means for mounting that complies with the Mounting Means Test, Section 64.

Exception: A unit within the specified weight limits of Table 54.1 and meeting the conditions for that weight limit is not required to comply with the Mounting Means Test.

Note: When compliance with 54.1 relies on a separable bracket (or similar), the bracket shall either be (a) packaged with the luminaire or (b) packaged separately with instructions or markings provided per 68.5.

Table 54.1
Mounting requirements

Weight	See footnote:
2-1/4 lb (1.0 kg) or less	(a or b) and (c or d)
4-1/4 lb (1.9 kg) or less	[(a or b) and d] or e

[a] A wall unit shall not project more than 7-1/2 in (190 mm) from a flat vertical wall on which the unit is mounted in the intended manner, including adjustable parts.

[b] The center of gravity of a wall unit shall not be more than 3 in (76.2 mm) from the vertical wall on which the unit is hung in the intended manner, the center of gravity being determined with any adjustment that gives a maximum projection from the wall.

[c] A unit is provided with either a ring-hanger, keyhole slot(s), or notch(es).

Table 54.1 Continued on Next Page

Table 54.1 Continued

Weight	See footnote:
[d] A unit is provided with mounting hardware consisting of at least two No. 6 Type A sheet metal screws of a length that the screws, when installed in the mounting holes, penetrate the mounting surface by not less than 3/4 in (19 mm).	
[e] A unit is provided with mounting hardware consisting of at least two No. 10 – 24 machine screws with mating hollow-wall anchors, or wing or expansion bolts. The screws shall be of a length that the anchors, or wing or expansion bolts are able to be installed through the mounting holes and a 3/4 in (19 mm) thick wall.	

54.1.1 A class 2 luminaire intended for recessed installation in a suspended ceiling and weighing more than 50 lb (22.7 kg) shall have provision for support independent of the ceiling grid.

54.2 A Class 2 luminaire whose mounting means includes magnets, adhesives, hook-and-loop fasteners, spring tension, or other means whose reliability is either dependent on the mounting means surface material or can be expected to deteriorate over time shall:

a) Comply with the Mounting Means Failure Test, Section 65; and

b) Be provided with installation instructions per 68.3

55 Glassware

55.1 A diffuser or lens constructed of flat glass shall be a minimum of 0.083 in (2.11 mm) thick and shall be secured by clips in a frame, channels, adhesive, or equivalent means.

Exception: Flat glass that does not require removal during relamping is able to be only secured by its own weight in a frame.

56 Tungsten-Halogen Lamp Containment Barrier and UV Filter

56.1 A luminaire rated for a tungsten-halogen lamp shall be:

a) Provided with a lamp containment barrier and UV filter that complies with the requirements of 56.1 – 56.7; or

b) The lamp is identified by the lamp manufacturer as not requiring an additional lamp containment barrier and/or UV filter and the luminaire is marked in accordance with 67.1.5.

56.2 A UV filter is not required when the luminaire is provided with instructions specifying that it be mounted at least 5 feet above the finished floor.

56.3 Lamp sources other than tungsten-halogen lamps, such as some xenon lamps, shall comply with the tungsten-halogen requirements when they are pressurized (internal pressure greater than 1 atmosphere cold).

56.4 The lamp containment barrier and UV filter shall be constructed of the following materials:

a) Metal, 0.016 in (0.41 mm) thick minimum;

b) Heat resistant soda lime glass, 1/8 in (3 mm trade size) thick for luminaires rated 100 W or more, 3/32 in (2.4 mm) for luminaires rated less than 100 W; or

c) Polymeric materials complying with Table 56.1 and the lamp containment barrier test in UL 1598.

Table 56.1
Ultraviolet transmission characteristics

Wavelength, nm	Maximum transmission, %
350	85
320	40
300	8
290	0.5
less than 280	0.1

56.5 For 56.4(b), glass other than soda-lime is able to be used when it complies with Table 56.1.

56.6 There shall be no openings in the containment barrier and UV filter which result in:

a) Direct line of sight to the lamp filament from the outside of the luminaire; and

b) Passage of a 0.125 in (3.2 mm) diameter rod through any containment barrier openings.

56.7 A lamp containment barrier shall be secured in position by:

a) A mechanical means that produces an interference fit;

b) A twist and lock means;

c) Spring clips;

d) Other mechanical means; or

e) The lamp.

CONSTRUCTION – ELECTRICAL

57 Leads and Conductors

57.1 Each lead subject to movement after installation, such as those connecting to an adjustable lampholder shall be of such length and design that the movement does not transmit stress or result in damage to the lead or connection. The connection shall comply with the Secureness of Conductors Test, Section 63.

57.2 An insulated conductor, including each insulated conductor of a cord, that is rated for 90°C (194°F), 105°C (221°F), or 125°C (257°F) is determined to be rated for 150°C (302°F) when each conductor is individually provided with supplementary insulation consisting of snugly fitting woven glass fiber sleeving having at least a 0.01 in (0.25 mm) wall thickness, or at least two layers of glass fiber tape having a total thickness of at least 0.01 in (0.25 mm).

57.3 The maximum luminaire weight supported by the flexible cord shall not exceed the following limits:

a) 2-1/2 lb (1.1 kg) for parallel cord type cords, such as SPT-2 or heavier;

b) 5 lb (2.27 kg) for vacuum cleaner type cords, such as SVT or heavier, when the cord is not subjected to kinks or sharp bends; and

c) 10 lb (4.54 kg) for junior hard service type cords, such as SJT or heavier.

58 Splices

58.1 A splice shall be located so that it is not disturbed when a lamp is being replaced.

59 Supply Connections

59.1 A luminaire intended for connection to only a Class 2 power unit that is shipped separately shall be marked per 67.3.2.

59.2 A Class 2 luminaire shall be constructed so it is able to be connected to the secondary wiring of a Class 2 power unit by one of the following means. Luminaires intended to be installed where the supply wiring is concealed shall comply with options (a) or (b) only. The supply end of the cord or wiring in options (c) or (d) shall not include a plug suitable for direct branch circuit connection or for connection to a USB (Universal Serial Bus) power unit. Proprietary connector types are permitted if the power unit is provided or is specified by manufacturer and model number, per 67.3.2.

a) Provision for mounting over a standard outlet box, connection to conduit or cable, or other means in accordance with Chapter 3 of NFPA 70;

b) A length of power limited cable that complies with UL 13 (CL2, CL3, and similar) or communication cable that complies with UL 444 (CM and similar) or equivalent, or wiring terminals suitable for connection of such cable;

c) A length of flexible cord identified in NEC Table 400.4 and that complies with UL 62, permanently connected to the luminaire, or detachable using a mating plug and connector; or

d) A length of appliance wiring material suitable for external use in accordance with UL 758, permanently connected to the luminaire or detachable using a mating plug and connector.

Informational note for (d): See 13.1.2 of UL 758 for the characteristics and related performance requirements for AWM suitable for external use.

59.3 An exposed bare conductor luminaire shall be constructed so it is able to be connected to conductors as described in Exposed Bare and Insulated Conductors, Section 30.

59.4 A luminaire or component shipped with a class 2 power unit, or marked per 67.3.2 for connection to a class 2 power unit, is permitted to be provided with means for grounding.

PERFORMANCE

60 Normal Temperature Test

60.1 A luminaire shall be subjected to a normal temperature test in accordance with 34.1 and 34.3. Where the light source is replaceable, the lamp shall be as marked per 67.1.3.

60.2 The luminaire shall be spaced no less than 12 in (305 mm) away from the power unit and shall be positioned so that the highest temperature on the mounting surface is achieved. An exposed bare conductor luminaire shall be installed per the manufacturer's instructions and using no less than 24 in (610 mm) of exposed bare conductor.

60.3 *Deleted*

60.4 A luminaire intended for installation in the storage area of a clothes closet shall be tested with glass fiber insulation batting positioned over and in contact with all exposed surfaces, including the light emitting surface. The insulation batting shall be rated RSI 1.4 to 1.9 (R8 to R11), in any convenient thickness.

61 Abnormal Recessed Temperature Test

61.1 A recessed luminaire marked “Type Non-IC” in accordance with 48.5.2 shall be installed as required and subjected to the Abnormal Temperature Test – Type Non-IC recessed luminaire (not intended for thermal insulation contact) as specified in UL 1598 Clause 16.2. If marked for specific installation spacings in accordance with 67.3.5, the test setup shall instead be as specified in UL 1598 Clause 16.3.

61.2 A recessed luminaire marked “Type IC” in accordance with 48.5.1 and with a replaceable light source shall be installed as required and subjected to the Abnormal Temperature Test – Type IC recessed luminaire (intended for thermal insulation contact) as specified in UL 1598.

61.3 When a recessed luminaire is subjected to the Abnormal Temperature Test using the test conditions described in 61.1 or 61.2, the luminaire complies when the thermal protector:

a) Operates within 3 h and no part of the luminaire in contact with thermal insulation or the test box exceeds 160°C (320°F); or

b) Does not operate within 3 h and the temperature limits specified in Table 34.1 are not exceeded during the test. Any part of the luminaire in contact with thermal insulation or the test box shall not exceed 90°C (194°F). The test shall be terminated after 7.5 h.

62 Luminaire Drop Impact Test

62.1 A polymeric housing shall be subjected to the drop impact test described in 62.2 and 62.3 and shall comply with the results in 62.4.

62.2 Each of three samples is to be dropped 3 ft (0.91 m) to strike a hardwood surface in the position most likely to produce adverse results. The hardwood surface is to consist of a layer of nominal 1 in (25 mm) tongue-and-groove oak flooring mounted on two layers of nominal 3/4 in (19 mm) plywood. The oak flooring is to be nominally 3/4 in thick (actual size 3/4 by 2-1/4 in or 18 by 57 mm). The assembly is to rest on a concrete floor or an equivalent nonresilient floor during the test.

62.3 Each sample is to be dropped three times so that, in each drop, the sample strikes the surface in a position different from those in the other two drops. Three samples shall be employed for the test, however, if the manufacturer so elects, fewer samples may be used in accordance with Figure 62.1. The overall performance is acceptable upon completion of any one of the procedures represented in Figure 62.1. If any sample does not comply on its first series of three drops, the results of the test are unacceptable.