



UL 8750

Underwriters Laboratories Inc. Standard for Safety

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



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

First Edition, Dated November 18, 2009

Summary of Topics

This First Edition of the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750, covers light emitting diode (LED) equipment as an integral part of a luminaire or other lighting equipment and which operates in the visible light spectrum between 400 – 700 nm. The publication of this First Edition reflects the new ANSI approval and incorporates the proposals dated May 29, 2009 and September 11, 2009. This standard includes the following changes from the Outline of Investigation:

- ***Revised title to reflect intended range of products covered by the standard***
- ***Revised Scope, Section 1, to reflect intended range of products covered by the standard***
- ***Added, removed, and revised glossary definitions***
- ***Removed General section and replaced with Power Supplies, LED Drivers, and Transformers***
- ***Added provision to Environmental Considerations for potted or conformal coated constructions***
- ***Revised Mechanical Construction to consolidate mechanical construction requirements into one section***
- ***Revised Electrical Construction to consolidate electrical construction requirements into one section***
- ***Revised Internal Wiring to expand considerations for wiring smaller than 18 AWG***
- ***Added requirements for both Permanently-Connected Units and Cord-Connected and Direct Plug-In Units***
- ***Added requirements for Coil Insulation for LED drivers employing coil forms***
- ***Relocated Performance Tests and Abnormal Conditions Tests into one section for Performance Tests***
- ***Relocated Markings section***
- ***Added supply wiring temperature marking***

The new requirements are substantially in accordance with Proposal(s) on this subject dated May 29, 2009 and September 11, 2009.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

NOVEMBER 18, 2009



ANSI/UL 8750-2009

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UL 8750

**Standard for Light Emitting Diode (LED) Equipment for Use in Lighting
Products**

First Edition

November 18, 2009

This ANSI/UL Standard for Safety consists of the First Edition.

The most recent designation of ANSI/UL 8750 as an American National Standard (ANSI) occurred on November 18, 2009 ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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

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Standards for Components..... A1

INTRODUCTION

1 Scope

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

1.2 These lighting products are intended for installation on branch circuits of 600 V nominal or less in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, and for connection to isolated (non-utility connected) power sources such as generators, batteries, fuel cells, solar cells, and the like.

1.3 LED equipment is utilized in lighting products that comply with the end-product standards listed below. The requirements in this standard are intended to supplement those in other end-product standards. Included are:

- a) Electric Signs, UL 48,
- b) Portable Electric Luminaires, UL 153,
- c) Underwater Luminaires and Submersible Junction Boxes, UL 676,
- d) Emergency Lighting and Power Equipment, UL 924,
- e) Stage and Studio Luminaires and Connector Strips, UL 1573,
- f) Track Lighting Systems, UL 1574,
- g) Luminaires, UL 1598,
- h) Direct Plug-In Nightlights, UL 1786,
- i) Low Voltage Landscape Lighting Systems, UL 1838,
- j) Self-Ballasted Lamps and Lamp Adapters, UL 1993,
- k) Luminous Egress Path Marking Systems, UL 1994, and
- l) Low Voltage Lighting Systems, UL 2108.

2 General

2.1 Components

2.1.1 Except as indicated in this clause, a component of a product covered by this standard shall comply with the requirements for that component. See the Standards for Components appendix for a list of standards covering components generally used in the products covered by this standard.

2.1.2 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.

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

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

2.2 Units of measurement

2.2.1 Except for conductor size, values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2.2 All values of voltage and current are true root mean square (rms) values unless otherwise indicated.

2.2.3 For customary purposes wire sizes are in American Wire Gauge (AWG).

2.3 Reference publications

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

3 Definitions

3.1 For the purpose of these requirements, the following definitions apply.

3.2 BARRIER – A part of the unit intended to physically limit access to parts that pose a risk of electric shock.

3.3 CIRCUIT, CLASS 2 – A circuit supplied by an isolating source that complies with the requirements of the Standard for Class 2 Power Units, UL 1310, or the Class 2 requirements of the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

3.4 CIRCUIT, ISOLATED LOW VOLTAGE LIMITED ENERGY (LVLE) – A circuit supplied by a source with no direct electrical connection between input and output, such as provided by a transformer or optical isolator, and with output parameters as follows: source with a maximum output voltage of 42.4 V peak ac (30 V rms) or 60 V dc; and a maximum output current limited to:

- a) maximum 8 amps for 0 – 42.4 V peak ac, or 0 – 30 V dc, or
- b) 150/V amps, for a voltage between 30 – 60 V dc.

Measurements for determining LVLE circuit status shall be per the requirements in Determination of Low-Voltage, Limited-Energy Circuit Status of 8.14.

3.5 ENCLOSURE, ELECTRICAL – A part of the equipment intended to limit access to parts that are operating at voltage levels in excess of Class 2 or LVLE.

3.6 ENCLOSURE, FIRE – A part of the equipment that is intended to minimize the spread of fire or flames from within a product.

3.7 ENVIRONMENTAL LOCATIONS

a) DRY LOCATION – 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.

b) DAMP LOCATION – 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.

c) WET LOCATION – A location in which water can drip, splash, or flow on or against electrical equipment.

3.8 INSULATION-PIERCING TERMINAL – A terminal having a contact pin that punctures the conductor insulation and penetrates between the conductor strands.

3.9 ISOLATED OUTPUT – A circuit with only magnetic, capacitive, or optical connection to any ground-referenced supply source. A low voltage circuit derived by a dropping resistor is not isolated.

3.10 LED (LIGHT EMITTING DIODE) – A solid-state component embodying a p-n junction, emitting optical radiation when excited by an electric current.

3.11 LED ARRAY (LED MODULE) – An assembly of one or more LED discrete electronic components on a printed circuit board, typically with optics and additional thermal, mechanical, and electrical interfaces.

3.12 LED CONTROL MODULE (LED CONTROLLER) – Electronic circuitry interposed between the power source and an LED array to dim, switch, or otherwise control the electrical energy to the LED array. The device does not contain a power source and is not connected directly to the branch circuit.

3.13 LED DRIVER – A power source that adjusts the voltage or current to LEDs, ranging in complexity from a resistor to a constant voltage or constant current power supply. Also referred to as Lamp Control Gear. (See also Power Source.)

3.14 LED PACKAGE – An assembly of one or more LED die that contains wire bond connections and may include an optical element and thermal, mechanical, and electrical interfaces. The package does not include a power source and is not connected directly to the branch circuit.

3.15 MEASUREMENT INDICATION UNIT (MIU) – The rms equivalent value of a 60 Hz sinusoidal leakage current in milliamperes (mA), adjusted to compensate as necessary for leakage currents composed of complex waveforms or frequencies other than 50 or 60 Hz. It is determined by dividing the output voltage (V₃) in millivolts (mV) rms by 500 (the value in ohms of the resistance in parallel with V₂) in the measurement instrument circuit in Figure 8.3.

3.16 PART, DEAD CONDUCTIVE – A conductive part with or without basic insulation that, under normal operating conditions, carries no electrical current. A grounded dead conductive part may carry only leakage current.

3.17 PART, HAZARDOUS LIVE – A part located in a circuit that is operating in excess of the risk of electric shock or risk of fire limits.

3.18 PART, LIVE – A conductive part that has an electrical difference of potential with respect to earth ground or any other conductive part. A part connected to a grounded supply (neutral) conductor is considered to be a live part.

3.19 PLC (PERFORMANCE LEVEL CHARACTERISTIC) VALUE – An integer that defines a range of test values for a given electrical/mechanical property test for polymeric (plastic) materials as defined in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

3.20 POWER LIMITED CIRCUIT – See Section 725 of the National Electrical Code (NEC), ANSI/NFPA 70, and Section 16 of the Canadian Electrical Code (CEC).

3.21 POWER SOURCE, CLASS 2 – An electrical source, such as a transformer or power supply that complies with the requirements of the Standard for Class 2 Power Units, UL 1310, or the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

3.22 POWER SOURCE, ISOLATED LOW VOLTAGE LIMITED ENERGY (LVLE) – A source as defined by 3.4.

3.23 POWER SUPPLY – An electronic device capable of controlling current, voltage, or power within its design limits.

3.24 **RISK OF ELECTRIC SHOCK** – A risk of electric shock exists between any two conductive parts or between a conductive part and earth ground if the open circuit potential is higher than 42.4 V peak ac (30 V rms) or 60 V dc, and the available current that flows between them exceeds 0.5 mA as determined by the Leakage Current Measurement Test, Section 8.7.

3.25 **RISK OF FIRE** – A risk of fire exists in all electrical circuits except:

- a) A Class 2 circuit, or
- b) An LVLE circuit.

3.26 **UNIT** – A generic term meaning any discrete device, subassembly, or assembly.

3.27 **UNIT, FIXED** – A unit intended to be permanently connected electrically to the wiring system.

3.28 **UNIT, PORTABLE** – A unit that is easily carried or conveyed by hand, and is provided with a power-supply cord for connection to the supply circuit.

3.29 **UNIT, STATIONARY** – A unit that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

4 Power supplies, LED Drivers, and Transformers

4.1 A power supply or LED driver that complies with any one of the following standards is considered to meet the intent of the requirements of this standard:

- a) The Standard for Class 2 Power Units, UL 1310,
- b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or
- c) The Standard for Power Units Other Than Class 2, UL 1012.

4.2 A transformer for use with LED units that complies with any one of the following is considered to meet the intent of the requirements of this standard:

- a) The Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3,
- b) The Standard for Transformers and Motor Transformers for Use in Audio-, Radio- and Television-Type Appliances, UL 1411,
- c) The Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2, or
- d) The Standard for Dry-Type General Purpose and Power Transformers, UL 1561.

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

CONSTRUCTION

5 Environmental Considerations

5.1 A unit intended for dry locations only shall be so identified and shall not be provided with any information such as markings, instructions, or illustrations that implies or depicts damp or wet use.

5.2 A unit intended for damp locations shall be:

- a) Subjected to the environmental tests of 8.12 unless all live parts and traces on the printed wiring board are potted (see 6.7) or conformal coated (see 7.7.2), and
- b) Eligible to be marked as suitable for damp locations, and not be provided with any information such as markings, instructions, or illustrations that implies or depicts wet use.

5.3 A unit intended for use in wet locations shall:

- a) Be subjected to the environmental tests of 8.12 unless all live parts and traces on the printed wiring board are potted (see 6.7) or conformal coated (see 7.7.2), and
- b) If provided with a polymeric enclosure, comply with the UV Light Exposure and Cold Impact Test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and
- c) Be eligible to be marked as suitable for wet locations.

6 Mechanical Construction

6.1 General

6.1.1 A unit intended to be used in an application identified by one of the standards specified in 1.3 shall comply with the mechanical construction requirements of that standard. If an end-use application is not specified or identified, or if a particular construction feature is not covered by the identified standard, the unit shall comply with the mechanical construction requirements of this section.

6.1.2 An enclosure of a unit shall prevent contact with uninsulated parts that represent a risk of electric shock, contain any fire initiated within the unit, and prevent mechanical damage to internal parts.

6.1.3 Circuits that represent a risk of electric shock or risk of fire shall be provided with an enclosure that complies with 6.2 or 6.3.

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

6.1.5 An adhesive used to secure the enclosure of a product that poses a risk of electric shock or risk of fire shall comply with the adhesive support test of 8.11. Fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding are permitted without test.

6.2 Metal thickness

6.2.1 The thickness of a metal enclosure shall be in accordance with Table 6.1.

Exception: A part of an enclosure that complies with the mechanical strength tests for metal enclosures of 8.13 need not comply with the thickness specified in Table 6.1.

Table 6.1
Minimum thickness of metal enclosures

Metal	At small, flat, unreinforced surfaces and at surfaces of a shape or size to provide adequate mechanical strength		At surfaces to which a wiring system is to be connected in the field		At relatively large unreinforced flat surfaces	
	mm	(in)	mm	(in)	mm	(in)
Die-cast	1.2	(3/64)	—	—	2.0	(5/64)
Cast malleable iron	1.6	(1/16)	—	—	2.4	(3/32)
Other cast metal	2.4	(3/32)	—	—	3.2	(1/8)
Uncoated sheet steel	0.66	(0.026)	0.81	(0.032)	0.66	(0.026)
Galvanized sheet steel	0.74	(0.029)	0.86	(0.034)	0.74	(0.029)
Nonferrous sheet metal other than copper	0.91	(0.036)	1.14	(0.045)	0.91	(0.036)

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

6.2.3 A protective coating need not be applied to steel enclosure parts when:

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

6.3 Polymeric materials for enclosures and electrical insulation

6.3.1 A polymeric material shall have an electrical, mechanical with impact and mechanical with strength relative thermal index (RTI), or a generic thermal index as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, that is equal to or greater than the temperature measured during the temperature test of 8.3.

6.3.2 A polymeric material used as an enclosure shall comply with the material characteristic requirements identified in Table 6.2 based on the specific application.

Table 6.2
Polymeric enclosure requirements

UL 746C performance characteristic	Power source		
	Class 2 & LVLE	Isolated non-Class 2	Direct connected
Enclosure Type Needed	None	Fire	Fire and Electrical
Relative Temperature Index (RTI)	No	Yes	Yes
Impact – 6.8 J (5 ft-lb)	No	Yes ^a	Yes ^a
Impact – 0.91 m (3 ft) drop	No	Yes ^b	Yes ^b
Impact with pre-conditioning ^c – 6.8 J (5 ft-lb)	No	Yes ^c	Yes ^c
UV Resistance	No	Yes ^d	Yes ^d
Flammability	No	5VA ^{e, f}	5VA ^{e, f}
Mold Stress	No	Yes	Yes
Comparative Tracking Index (CTI)	No	No	PLC of 4 ^g
Hot Wire Ignition, (HWI)	No	No	PLC of 3 ^g
High Ampere Arc (HAI)	No	No	PLC of 2 ^g
^a 6.8 J (5 ft-lb) impact for dry or damp location, fixed or stationary units ^b 0.91 m (3 ft) drop impact for portable units ^c For damp or wet location, fixed units, to be conducted after cold conditioning in accordance with UL 746C ^d For wet location units ^e V2 for portable units and Track Lighting Luminaires ^f V1 for the lens (optic) of an LED package ^g Not required when all live parts are > 0.8 mm from the material			

6.3.3 A conductive coating applied to a surface such as the inside surface of a cover, enclosure, and the like shall comply with the appropriate requirements for metallized parts in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, unless it can be determined that flaking or peeling of the coating does not result in a reduction of spacing of electrical parts or the bridging of live parts that may result in a risk of fire or electric shock.

6.3.4 The lens (optic) of an LED package connected in a circuit that represents a risk of electric shock need not be provided within an enclosure if made of:

- a) Glass, or
- b) A polymeric material that complies with the dielectric voltage withstand test of 8.4 when a 500-V potential is applied between the electrical connections to the LED and the lens surface.

6.3.5 The lens (optic) of an LED package connected in a circuit that represents a risk of fire need not be provided within an enclosure if made of a material having a flammability rating as noted in footnote f of Table 6.2.

6.4 Enclosure openings

6.4.1 Other than for supply connections, open holes shall not be permitted in any surface of a fire or electrical enclosure.

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

6.4.2 Open holes shall be permitted for units not intended for installation in a concealed space. Line of sight to open core and coil components shall be louvered or baffled.

6.5 Conductor protection

6.5.1 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 1.1 mm (0.042 in) thick, protection shall be provided by one of the following methods:

- a) Rolling the edge of the metal not less than 120 degrees,
- b) A bushing or grommet of a material other than rubber at least 1.2 mm (0.047 in) thick, or
- c) Glass sleeving at least 0.25 mm (0.010 in) thick.

6.6 Strain relief

6.6.1 For any accessible conductor operating above Class 2 or LVLE limits, a strain relief and cord push back means shall be provided that complies with the cord strain pushback relief test requirements of 8.8, where cord or lead wire displacement could result in:

- a) Subjecting the supply cord or lead to mechanical damage,
- b) Exposing the supply cord or lead to a temperature higher than that for which it is rated,
- c) Reducing spacing (such as to a metal strain-relief clamp) below the minimum required values, or
- d) Damage to internal connections or components.

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

6.7 Potting compound

6.7.1 Potting compound shall not leak, drip, or be released from a unit while under condition of testing, and shall not exceed its Relative Thermal Index (RTI) during the temperature test of 8.3.

6.7.2 Asphalt potting compound shall remain at least 15°C (27°F) below its softening point as determined by the Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus, ASTM E28.

7 Electrical Construction

7.1 General

7.1.1 A unit intended to be used in an application identified by one of the standards specified in 1.3 shall comply with the electrical construction requirements of that standard. If an end-use application is not specified or identified, or if a particular construction feature is not covered by the identified standard, the unit shall comply with the electrical construction requirements of this section.

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

7.1.3 An uninsulated live part shall be secured so that it does not turn or shift in position if such motion results in a reduction of spacings below the minimum acceptable values.

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

7.2 Accessibility

7.2.1 A live part that is a risk of electric shock shall be located so it is inaccessible to contact using the articulate probe shown in Figure 7.1, applying a force not exceeding 4.45 N (1 lbf).