SUBJECT 8750

OUTLINE OF INVESTIGATION

FOR

LIGHT EMITTING DIODE (LED) LIGHT SOURCES FOR USE IN LIGHTING PRODUCTS

Issue Number: 1

JANUARY 31, 2007

Summary of Topics

This is the first issue of the Outline of Investigation for Light Emitting Diode (LED) Light Sources For Use In Lighting Products. The outline covers the component parts of a light emitting diode (LED) light source such as LED modules, LED Arrays, power sources and control circuitry. It covers LED light sources that are produced by the end use product manufacturer, and that are an integral part of the end use product, or discrete component parts of an LED light source produced by one manufacturer for use in another manufacturer's lighting product.

The UL Foreword is no longer located within the UL Outline of Investigation. For information concerning the use and application of the requirements contained in this Outline of Investigation, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The text included in paragraphs 3.14.1, 3.14.2, and 3.14.2, and Tables 3.1 and 3.2 are based on material in Information Technology Equipment – Safety – Part 1: General Requirements, IEC 60950-1, First edition copyright 1999-01. This material is used in this Standard with the consent of the IEC and the American National Standards Institute (ANSI). The IEC copyrighted material has been reproduced with permission from ANSI. ANSI should be contacted regarding the reproduction of any portion of the IEC material. Copies of the IEC Publication 60950-1 may be purchased from ANSI, 11 West 42nd Street, New York, New York, 10036, (212)642-4900.

COPYRIGHT © 2007 UNDERWRITERS LABORATORIES INC.

Document was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

No Text on This Page

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

CONTENTS

INTRODUCTION

1 Scope 5
2 General 6
2.1 Components 6
2.2 Units of measurement 6
2.3 Reference publications 7
3 Definitions 7
4 General Requirements And Use Of This Outline of Investigation 11
4.1 General 11
4.2 LED modules 11

CONSTRUCTION

5 Environmental Considerations 12
6 Mechanical Construction 13
6.1 General 13
6.2 Metal enclosures 13
6.3 Polymeric materials for enclosures and electrical insulation 14
6.4 Barriers 15
6.5 Conductor protection 16
6.6 Strain relief 16
7 Electrical Construction 17
7.1 General 17
7.2 Accessibility of hazardous live parts 17
7.3 Hazardous live parts other than exposed wiring terminals 18
7.4 Exposed wiring terminals 18
7.5 Internal wiring 19
7.6 Supply and load connections 20
7.7 Separation of circuits 22
7.8 Insulating materials 22
7.9 Printed wiring boards 23
7.10 Spacing of electrical parts 24
7.11 Circuit components 26
7.12 Protective devices 27
8 LED Power Source 28
8.1 General 28
8.2 Power source enclosure 28
8.3 Power supplies 30
8.4 Transformers 31
9 LED and Control Modules 31
9.1 General 31
9.2 Enclosures 31
9.3 Enclosure openings 32
9.4 Conditions of use for component LED and control circuit modules 33

Document was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

PERFORMANCE

10 Performance Tests 33
10.1 General 33
10.2 Input test 33
10.3 LED module normal operations temperature test 34
10.4 Dielectric voltage withstand test 34
11 Abnormal Tests 35
11.1 General 35
11.2 Unreliable component abnormal test 36
11.3 50-W point power measurement test 36

MARKINGS

12 Markings 37
12.1 General 37
12.2 Required markings 38

APPENDIX A

Standards for Components A1

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

INTRODUCTION

1 Scope

1.1 These requirements specify the minimum safety requirements for the component parts of a light emitting diode (LED) light source that serves as the source of illumination in any of the lighting products listed in 1.3.

1.2 An LED light source consists of one or more of the following component parts:

a) LED or LED array – that provide illumination,

b) Power source that supplies the proper voltage and current to operate the LEDs,

c) Control circuitry that may switch, dim or otherwise control the electrical energy to the LEDs.

1.3 LED light sources complying with these specifications are utilized as the source of illumination in lighting products that comply with the appropriate end product standard as listed below. These lighting products are intended for installation on branch circuits of 600 V nominal or less in non-hazardous locations in accordance with the National Electrical Code (NEC), ANSI/NFPA 70. These requirements also apply to LED light sources connected to isolated (non-utility connected) power sources such as batteries, fuel cells, and the like. Included are:

a) Luminaires, UL 1598;

b) Portable luminaires, UL 153;

c) Stage and studio luminaires, UL 1573;

d) Submersible luminaires, UL 676;

e) Swimming pool luminaires, UL 676;

f) Track lighting systems, UL 1574 ;

g) Signs, UL 48;

h) Emergency lighting and exit signs, UL 924;

i) Self-ballasted lamps, UL 1993;

j) Luminous Egress Path Marking Systems, UL 1994;

k) Nightlights, UL 1786;

l) Flexible lighting, UL 2388;

m) Low Voltage Lighting Systems, UL 2108;

n) Lampholder Fittings, UL 496; and

o) Landscape Lighting, UL 1838.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

1.4 Applications incorporating LED light sources such as lighting products for use in hazardous locations, health care, emergency lighting or marine lighting have additional requirements not described in this outline of investigation.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this outline shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this outline.

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 outline, or

b) Is superseded by a requirement in this outline.

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).

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

2.3 Reference publications

2.3.1 Any undated reference to a code or standard appearing in the requirements of this outline 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 CONDITIONS OF USE – Parameters and specifications that identify the proper use of a component according to the requirements to which it has been determined to comply, and limitations of the use of the component in an LED module or control gear.

3.3 ENCLOSURE, ELECTRICAL – A part of the equipment intended to limit access to parts that are operating at voltage levels exceeding a Class 2, SELV or a limited power source.

3.4 ENCLOSURE, FIRE – A part of the equipment that limits access to hazardous live parts and is intended to minimize the spread of fire or flames from within.

3.5 ENCLOSURE, MECHANICAL – A part of the equipment intended to reduce the risk of injury due to mechanical and other physical hazards.

3.6 LAMP – A generic term for a man-made source of light. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible. In lighting parlance, the lamp is the replaceable light-generating component of a luminaire, usually a standardized element with a standard base, such as a screw base, pin base, or bayonet base, for mechanical and electrical coupling.

3.6.1 LED LAMP, INTEGRATED – An LED device with an integrated driver and an ANSI standardized base that is designed to connect to the branch circuit via an ANSI standardized lampholder.

Note: In North America, “a standardized base” refers to an ANSI standard base. In the U.S. “branch circuit” is used to describe the “mains voltage” in IEC documents.

3.6.2 LED LAMP, NON-INTEGRATED – An LED device with no integral power source and with an ANSI standardized base designed for connection to a LED luminaire.

3.7 LED LUMINAIRE – A complete lighting unit consisting of a LED light source and power source together with parts to distribute light, to position and protect the light source, and to connect the light source to a branch circuit. The LED light source may be an LED array, an LED module or an LED lamp. The LED luminaire is intended to connect directly to a branch circuit.

3.8 LIGHT EMITTING DIODE (LED) – A pn junction semiconductor device that emits incoherent optical radiation when biased in the forward direction.

3.8.1 LED ARRAY – An assembly of LED packages on a printed circuit board, possibly with optical elements and additional thermal, mechanical, and electrical interfaces. The device does not contain a power source and is not connected directly to the branch circuit.

3.8.2 LED MODULE – A component part of an LED light source that includes one or more LEDs that are connected to the load side of LED power source or LED driver. Electrical, electronic, optical, and mechanical components may also be part of an LED module. The device does not contain a POWER SOURCE and is not connected directly to the branch circuit.

Document was downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
at 2360 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

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

3.9 LIGHTING UNIT, FIXED – A power source or LED luminaire that is intended to be permanently connected electrically to a branch circuit supply and fastened in place.

3.10 LIGHTING UNIT, PORTABLE – A power source or LED luminaire with a flexible cord and attachment plug to connect it to the supply circuit, that has no provision for attaching it to a supporting surface and is easily carried or conveyed by hand.

3.11 LIGHTING UNIT, STATIONARY – A power source or LED luminaire that is intended to be fastened in place or located in a dedicated space, and is provided with a flexible cord and attachment plug to connect it to a branch circuit supply.

3.12 LIVE PART – A conductive part that has an electrical difference of potential with respect to earth ground or any other conductive part and no basic insulation. A part connected to a grounded supply (neutral) conductor is considered to be a live part.

3.12.1 DEAD CONDUCTIVE PART – A conductive part with no basic insulation that, under normal operating conditions, carries no electrical current. A grounded dead conductive part may carry leakage current.

3.13 POLLUTION DEGREES – The level of pollution present at the location on or in a product where the clearance and creepage distance measurement is made, and can be controlled by design of the product.

a) POLLUTION DEGREE 2 – Normally only non-conductive pollution; however, temporary conductivity is capable of being caused by condensation.

b) POLLUTION DEGREE 3 – Conductive pollution, or dry, non-conductive pollution that becomes conductive due to condensation.

3.14 POWER SOURCE – A transformer, power supply, or battery capable of controlling current, voltage or power within its design limits.

3.14.1 CIRCUIT, EXTRA-LOW VOLTAGE – A secondary circuit with voltages between any two conductors of the circuit, and between any one such conductor and earth ground, not exceeding 42.4 V peak, or 60 V dc, under normal operating conditions, which is separated from hazardous voltage by basic insulation, and which neither meets all of the requirements for an SELV circuit nor meets all of the requirements for a limited current circuit.

3.14.2 CIRCUIT, LIMITED CURRENT – A circuit that is so designed and protected that, under both normal operating conditions and single fault conditions, the current, which can be drawn, is not hazardous (does not exceed Class 2 limits.)

3.14.3 CIRCUIT, SAFETY EXTRA-LOW VOLTAGE (SELV) – A secondary circuit that is so designed and protected that under normal operating conditions and single fault conditions, its voltages are less than 30 V rms (42.4 V peak) or 60 V DC.

3.14.4 LED CONTROL MODULE – Electronic circuitry interposed between the power source and an LED array to limit voltage and current, 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.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
11600 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

3.14.5 LED DRIVER – A power source with integral control circuitry designed to meet the specific requirements of a LED lamp or a LED array.

3.14.6 LED DRIVER, CLASS 2 – A LED driver that operates within Class 2 limits.

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

3.14.8 POWER SOURCE, CLASS 2 – An electrical source, such as a transformer, power supply, or battery, having an open-circuit voltage that is less than 30 V rms (42.4 V peak) or 60 V DC and having limited energy available in the circuit under load conditions, including short-circuit and extremely low resistance. A Class 2 supply source can be either inherently limited or non-inherently limited.

a) INHERENTLY LIMITED POWER SOURCE – A transformer, power supply or battery having no discrete protective device that is relied upon to limit the output energy available from the supply. A power supply or battery with internal current and energy limiting circuitry shown to be reliable is eligible to be identified as inherently limited. Transformers, power supplies and batteries may be provided with protective devices as long as they are not relied upon to limit the output.

b) NON-INHERENTLY LIMITED POWER SOURCE – A transformer, power supply or battery having a discrete protective device that automatically interrupts the output when the current and energy output reaches a prescribed limit.

3.14.9 POWER SOURCE, LIMITED POWER SOURCE (LPS) – A power source identified as ″LPS″ where the output is limited as specified in Tables 3.1 and 3.2. The output of an LPS is considered equivalent to power supplies with Class 2 outputs.

Table 3.1
Limits for inherently limited power sources

Output voltage [1] (U_{oc})		Output current [2] (I_{sc})	Apparent power [3] (S)
V a.c.	V d.c	A	VA
≤ 20	≤ 20	≤ 8.0	≤ 5 × U_{oc}
20 < U_{oc} ≤ 30	20 < U_{oc} ≤ 30	≤ 8.0	≤ 100
–	30 < U_{oc} ≤ 60	≤ 150/ U_{oc}	≤ 100

[1] U_{oc}: Output voltage measured in accordance with 10.1 with all load circuits disconnected. Voltages are for substantially sinusoidal a.c. and ripple free d.c. For non-sinusoidal a.c. and for d.c.with ripple greater than 10% of the peak, the peak voltage shall not exceed 42.4 V.

[2] I_{sc}: Maximum output current with any non-capacitive load, including a short circuit, measured 60 S after application of the load.

[3] S (VA): Maximum output VA with any non-capacitive load measured 60 s after application of the load.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Table 3.2
Limits for power sources not inherently limited (overcurrent protective device required)

Output voltage [1] (U_{oc})		Output current [2] (I_{sc})	Apparent power [3] (S)	Current rating of overcurrent protective device [4]
V a.c.	V d.c.	A	VA	A
≤ 20	≤ 20	≤ 1 000/U_{oc}	≤ 250	≤ 5.0
20 < U_{oc} ≤ 30	20 < U_{oc} ≤ 30			≤ 100/U_{oc}
–	30 < U_{oc} ≤ 60			≤ 100/U_{oc}

[1] U_{oc}: Output voltage measured in accordance with 10.1 with all load circuits disconnected. Voltages are for substantially sinusoidal a.c. and ripple free d.c. For non-sinusoidal a.c. and for d.c. with ripple greater than 10% of the peak, the peak voltage shall not exceed 42.4 V.

[2] I_{sc}: Maximum output current with any non-capacitive load, including a short circuit, measured 60 s after application of the load. Current limiting impedances in the equipment remain in the circuit during measurement, but overcurrent protective devices are bypassed.

[3] S (VA): Maximum output VA with any non-capacitive load measured 60 s after application of the load. Current limiting impedances in equipment remain in the circuit during measurement, but overcurrent protective devices are bypassed.

NOTE The reason for making measurements with overcurrent protective devices bypassed is to determine the amount of energy that is available to cause possible overheating during the operating time of the overcurrent protective devices.

[4] The current ratings of overcurrent protective devices are based on fuses and circuit breakers that break the circuit within 120 s with a current equal to 210% of the current rating specified in the table.

3.15 RATED MAXIMUM TEMPERATURE, T_c – A temperature limit assigned by the manufacturer to a specified location marked on the outer surface of the LED module that is not to be exceeded (under normal operating conditions in the end product). The assigned T_c is related to the product's reliable operation, and is not necessarily a safety limit.

3.16 RISK OF ELECTRIC SHOCK – A risk of electric shock exists between any two conductive parts with no basic insulation or between a conductive part with no basic insulation and earth ground if the continuous current flow through a 1500 Ω resistor in parallel with a 0.15µF capacitor connected between the two points exceeds 5 mA rms (7 mA peak) and if the open circuit voltage exceeds 30 V rms (42.4 V peak) ac or 60 V DC for dry or damp locations or 15 V (21.2 V peak) AC or 30 V DC for wet locations.

3.17 RISK OF FIRE – A risk of fire exists between two conductive parts with no basic insulation if I_{max} or VA_{max} exceeds Class 2 circuit limitations as defined in Section 725 of the National Electrical Code (NEC).

3.18 UNIT – A generic term meaning a power source, control module or LED module.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM
UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

4 General Requirements And Use Of This Outline of Investigation

4.1 General

4.1.1 This document has a dual purpose of providing requirements for the evaluation of components of a LED light source either has a discrete component or as integrated (power supply and LED lamp on a single circuit board) into various lighting products that would additionally be evaluated with additional end-product standards described in the scope. When components are evaluated with additional end product standards, the requirements of the end product standard supersede these requirements.

4.1.2 Sections 5 through 7, and 12 give common requirements for any of the components of a LED light source. Section 8 contains supplementary requirements that pertain to LED power source components, while Section 9 contains supplementary requirements that pertain to LED and control module components.

4.1.3 To use this outline, a product's function and intended environmental uses would first be determined along by either review of product markings or discussion with the manufacturer.

4.1.4 Units, which are marked "Double Insulated," or marked with the symbol for double insulation, shall comply with the requirements of be investigated to the Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097.

4.2 LED modules

4.2.1 Integral modules not having their own enclosure shall be treated as integral components of the end product luminaire and comply with the component requirements specified in the end product standard. They shall be tested as far as applicable in accordance with this outline.

4.2.2 Independent modules shall comply, in addition to this outline, with the requirements of relevant clauses of the end product standard, where these requirements are not already covered in this outline.

4.2.3 If the module is a factory sealed unit, it shall not be opened for any tests. In the case of doubt based on the inspection of the module and the examination of the circuit diagram, and in agreement with the manufacturer or responsible vendor, such specially prepared modules shall be submitted for testing so that a fault condition can be simulated.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

CONSTRUCTION

5 Environmental Considerations

5.1 A unit not subjected to additional construction features or testing for environmental conditions is intended for use only in dry locations and is to be marked as such. The unit shall not be provided with any information such as markings, instructions, or illustrations either on the carton or with the device that implies or depicts a damp or wet location use.

5.2 A unit intended for use in damp locations, such as within an enclosed outdoor luminaire, shall be:

a) Subjected to the Humidity Test in the Standard for Fluorescent-Lamp Ballasts, UL 935, Section 23;

b) Have spacing of electrical parts meeting damp or wet location requirements, or Pollution Degree 2 as specified in Spacing of Electrical Parts, Section 7.10; and

c) Be marked as specified in 12.2.5.

5.3 A unit intended for use in wet locations shall be:

a) Subjected to the Humidity Test in the Standard for Fluorescent-Lamp Ballasts, UL 935, Section 23;

b) Have spacing of electrical parts meeting damp or wet location requirements, or Pollution Degree 3 as specified in Spacing of Electrical Parts, Section 7.10;

c) Have polymeric enclosures comply with the UV rating described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, Section 57;

d) Subjected to the Water Spray Test in the Standard for Luminaires UL 1598, Section 16.5.2;

e) Have polymeric enclosures be subjected to the Cold Impact Test in UL 746C, Section 56; and

f) Be marked as specified in 12.2.5.

5.4 A unit intended for use in constant contact with water, (e.g. installed on the bottom of a sign body or the enclosure of the outdoor portion of an outdoor sign or a submersible wet locations) shall be:

a) Subjected to the Humidity Test in the Standard for Fluorescent-Lamp Ballasts, UL 935, Section 23;

b) Have spacing of electrical parts meeting damp or wet location requirements, or Pollution Degree 3 as specified in Spacing of Electrical Parts, Section 7.10;

c) Have polymeric enclosures comply with the UV rating described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, Section 57;

d) Subjected to the Water Exposure and Immersion Test in UL 746C;

e) Have polymeric enclosures be subjected to the Cold Impact Test in UL 746C, Section 56; and

Document was Downloaded By jordan jordan
For use BY RICHFIELD HOME PRODUCTS LTD
27600 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

f) Be marked as specified in 12.2.5.

6 Mechanical Construction

6.1 General

6.1.1 Enclosures shall have the strength and rigidity required to resist the abuses expected to be encountered in use without increasing the risk of fire, electric shock or injury to persons due to a reduction in required spacing between live parts or live parts and dead parts or the loosening or displacement of such parts. The requirements in Section 6 shall be used in conjunction with the applicable supplementary requirements in this outline.

6.1.2 All parts operating above Class 2 or LPS limits shall be enclosed within a qualifying material.

Note: The parts that are required to be enclosed are all parts connected to an electrical circuit that is NOT designated Class 2 or LPS and the live parts are not otherwise intended to be enclosed in the end product

6.1.3 The enclosure shall be designed to reduce the risk of electric shock and mechanical damage to component parts, and contain fire within it.

6.1.4 Components with integral electrical enclosures that comply with the enclosure requirements for the component are considered to comply.

6.1.5 Components where the electrical enclosure is provided as part of the end product are not required to have an integral electrical enclosure.

6.2 Metal enclosures

6.2.1 Sheet metal and cast enclosures shall have a minimum thickness in accordance with Table 8.1 in the Standard for Class 2 Power Supplies, UL 1310.

6.2.2 An enclosure constructed of iron or steel shall be protected against corrosion by plating, painting, or the equivalent. Both inside and outside surfaces of an enclosure shall be protected against corrosion.

6.2.3 A protective coating need not be applied to:

a) The interior of an enclosure that is completely filled with potting compound; or

b) Flat metal surfaces that are tightly clamped together.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

6.3 Polymeric materials for enclosures and electrical insulation

6.3.1 An enclosure or electrical insulator of polymeric material shall comply with the requirements in this section and 8.2 for power sources and 9.2 for LED modules and control modules. Polymeric material includes thermoplastic and thermosetting materials and composite type materials bonded together by organic compounds. Thermosetting material, such as phenolic and epoxy, is a polymeric material that are cast rather than molded.

6.3.2 The relative thermal index (RTI) or temperature rating of a polymeric material shall be equal to or greater than the temperature measured during the normal temperature test, see 10.3:

a) The mechanical temperature index, determined with respect to impact and long-term aging, of at least the measured temperature; and

b) Have an electrical temperature index, determined with respect to long-term aging, of at least the measured temperature when the part is involved in the direct or indirect support of a live part; and,

c) Be equal to or greater than the temperature measured during the normal temperature test; or

d) Be a material without an RTI rating that has been accepted for the measured temperature as a generic material class in accordance with the table for relative thermal indices based upon past field-test performance and chemical structure in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

6.3.3 In addition to the performance tests specified in this outline, the factors to be considered when evaluating a polymeric enclosure are:

a) Material flammability properties;

b) Resistance to arcing properties; and

c) Moisture absorptive properties.

These properties shall comply with the requirements specified in Tables 8.2 and 9.1.

6.3.4 A conductive coating applied to a nonmetallic surface such as the inside surface of a cover, enclosure, and the like shall comply with the appropriate requirements for metallized parts, in Section 44 of 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 spacings or the bridging of live parts that may result in a risk of fire, electric shock, or injury to persons.

6.3.5 An adhesive used in the assembly of the enclosure shall be investigated as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.3.6 A method of assembly utilizing fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding need not be investigated.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

6.3.7 A polymeric enclosure material shall comply with the following tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C as outlined in Table 8.2 for a power source and Table 9.1 for an LED module or control module.

6.4 Barriers

6.4.1 An insulating barrier or liner used to provide electrical spacings shall be of material that complies with Section 7 of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and shall not be less than 0.028 in (0.71 mm) thick.

6.4.2 A barrier or liner used in conjunction with not less than half the required spacing through air may be less than 0.028 in (0.71 mm) thick, but not less than 0.012 in (0.305 mm) thick if the barrier or liner is of insulating material that complies with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and is:

a) Resistant to moisture;

b) Of acceptable mechanical strength if exposed or otherwise likely to be subjected to mechanical damage;

c) Reliably held in place; and

d) Located so that it is not adversely affected by operation of the device – particularly arcing.

6.4.3 A barrier or liner in the secondary circuit where the potential is not more than 50 V may be less than 0.028 in (0.71 mm) thick but not less than 0.010 in (0.25 mm) thick if it is:

a) Resistant to moisture;

b) Of acceptable mechanical strength if exposed or otherwise likely to be subjected to mechanical damage; and

c) Reliably held in place.

6.4.4 Insulating material having a thickness less than that specified in 6.4.1 may be used if, upon investigation, it is found to be acceptable for the application, and has a dielectric breakdown strength of not less than 5000 V in the thickness used for 6.4.1, or 2500 V in the thickness used for 6.4.2, as determined by the Tests on Insulating Materials, the Standard for Class 2 Power Units, UL 1310.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

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 0.042 in (1.1 mm) 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 0.047 in (1.2 mm) thick; or

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

6.6 Strain relief

6.6.1 General

6.6.1.1 Strain relief shall be provided for the supply cord and output wiring.

6.6.1.2 A strain-relief device, including a bushing with an integral strain-relief means, shall be designed to limit the holding pressure without damaging the cord jacket or conductor insulation.

6.6.1.3 Means shall be provided to prevent the cord or wiring from being pushed into the enclosure through the cord-entry hole when such displacement results 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 spacings (such as to a metal strain-relief clamp) below the minimum required values; or

d) Damaging internal connections or components.

6.6.1.4 Strain relief shall be provided for an accessible conductor in a circuit operating at voltage and current levels that exceed Class 2 limits.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

6.6.2 Flexible cord

6.6.2.1 A strain relief for a flexible cord shall comply with the 156 N (35 lbf) strain-relief test of Section 16.21.1, the Standard for Luminaires, UL 1598.

6.6.2.2 Push back relief for the supply cord or lead shall be tested in accordance with the Push-Back Relief Test, the Standard for Class 2 Power Units, UL 1310.

6.6.3 Conductors

6.6.3.1 The strain relief for a conductor shall comply with the 89 N (20 lbf) pull test of Section 16.21.2, the Standard for Luminaires, UL 1598.

7 Electrical Construction

7.1 General

7.1.1 The requirements in Section 7 shall be used in conjunction with the applicable supplementary requirements in this outline.

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 of hazardous live parts

7.2.1 A hazardous live part shall be located or enclosed so that the risk of contact is reduced.

7.2.2 A guard, baffle, or cover that can be removed without using a tool is to be removed when determining if a live part is accessible to the user.

7.2.3 Accessibility shall be determined by the articulate probe test of Section 16.2, the Standard for Class 2 Power Units, UL 1310.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.3 Hazardous live parts other than exposed wiring terminals

7.3.1 The test pin and articulate probe illustrated in Figures 16.1 and 16.2 respectively of the Standard for Class 2 Power Units, UL 1310, when applied as indicated in 7.3.2, shall not contact:

a) A primary circuit; or

b) Any live part with a voltage greater than that specified in 7.3.2 with respect to ground or any other live part simultaneously accessible to the test pin or articulate probe.

7.3.2 The maximum voltages that may be accessible in accordance with 7.3.1(a) are:

a) 42.4 V peak for sinusoidal or non-sinusoidal AC;

b) 60 V for continuous DC;

c) 24.8 V peak for DC interrupted at a rate of 200 Hz or less with approximately 50 percent duty cycle; and

d) As indicated in Figure 16.3 of the Standard for Class 2 Power Units, UL 1310, for combinations of AC and DC.

For the purpose of this requirement, initial transients lasting less than 200 ms may be ignored. Since short-term peak voltage is of interest during tests involving a fault, voltages are to be monitored by using a storage oscilloscope for the first 2 s after any fault is introduced.

Exception: The voltage may be exceeded if the current between the parts does not exceed 0.5 mA when measured in accordance with the Leakage Current Test of the Standard for Class 2 Power Units, UL 1310.

7.3.3 The test pin and articulate probe referenced in 7.3.1 are to be applied with a force not exceeding 1 lbf (4.4 N) to determine whether the live parts are accessible. The test pin shall not be applied to fuse holders.

7.4 Exposed wiring terminals

7.4.1 The accessibility probe illustrated in Figure 16.4 of the Standard for Class 2 Power Units, UL 1310, when applied as indicated in 7.4.3, shall not contact an exposed wiring terminal with a voltage greater than that specified in 7.4.2 with respect to ground or to any other terminal simultaneously accessible to the probe.

7.4.2 The maximum voltages that may be accessible in accordance with 7.4.1 are:

a) 42.4 V peak for sinusoidal or non-sinusoidal AC;

b) 42.4 V for continuous DC;

c) 24.8 V peak for DC interrupted at a rate of 200 Hz or less with approximately 50 percent duty cycle; and

d) 42.4 V peak for combinations of AC and DC.

Document Was Downloaded By jordan jordan
For Use BY RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.4.3 The accessibility probe referenced in 7.4.1 is to be applied with a force not exceeding 5.62 lbf (25 N) to determine whether the exposed wiring terminals are accessible. Prior to applying the probe the largest size conductors permitted by Table 45.1 of the Standard for Class 2 Power Units, UL 1310, are to be secured by the wire binding screws.

7.5 Internal wiring

7.5.1 Internal wiring shall consist of insulated conductors having the mechanical strength, dielectric voltage withstand properties and ampacity for the application. See 7.6.

7.5.2 Each splice and connection shall be mechanically secure, shall provide reliable electrical contact, and shall be provided with insulation at least equivalent to that of the wire involved unless acceptable permanent spacing between the splice and all other metal parts will be maintained. When determining the required minimum thickness of splice insulation, the circuit voltage and interaction with other circuits shall be taken into consideration.

7.5.3 A wire connector for making a splice in a unit shall be a type that is applied by a tool in which the application force of the tool making the splice is independent of the force applied by the operator of the tool.

7.5.4 The connection between a lead wire, including a flexible cord, and the transformer winding or other part of the unit shall be securely connected within the enclosure. Soldering or welding are examples of suitable means to accomplish this. A soldered joint shall be mechanically secureed before soldering.

7.5.5 If a wire is rigidly held in place without the use of solder, or if it is retained in place so as not to be subjected to any motion, no additional mechanical security is required. Mechanical securing of a lead is not required if separation of the connection does not result in a risk of fire or electric shock.

7.5.6 Unless it is to be evaluated as an uninsulated live part, insulated internal wiring – including an equipment-grounding conductor – shall consist of wire of a type or types acceptable for the application, when considered with respect to:

a) The temperature and voltage to which the wiring is likely to be subjected;

b) Exposure to oil, grease, cleaning fluid, or other substances likely to have a deleterious effect on the insulation; and

c) Other conditions of service to which it is likely to be subjected.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.6 Supply and load connections

7.6.1 General

7.6.1.1 The input and output connections of a power source shall comply with the applicable Standard as specified in Section 8.

7.6.1.2 The input and output connections of an unit shall be provided with a cord, lead wire, terminals, or output connectors.

7.6.2 Input and output wiring

7.6.2.1 The wiring shall be stranded or solid conductors having insulation not less than 0.013 in (0.33 mm) thick, and permanently attached to the output circuit. The wiring shall extend at least 6 in (150 mm) outside the unit, and shall comply with the requirements in 6.6.

7.6.2.2 With respect to 7.6.2.1, for units with jacketed multi-conductor output wiring, the individual conductor insulation may be less than 0.013 in (0.33 mm) provided that the following conditions are met:

a) The thickness of the individual conductor insulation plus the thickness of the jacket is not less than 0.013 in; and

b) The unit complies with the requirements of the maximum output voltage test, Section 28, and the inherently limited test, Section 30.2.1 of the Standard for Class 2 Power Units, UL 1310, with any combination of output conductors interconnected.

7.6.2.3 A fitting having female contacts shall be constructed so that it does not receive the blades of a standard attachment plug. A fitting having male contacts shall be constructed so that the contacts do not touch a live part of a standard attachment-plug receptacle.

7.6.3 Screw type terminals

7.6.3.1 A terminal plate tapped for a wire-binding screw or stud shall be of brass or other nonferrous metal, or plated steel, not less than 0.030 in (0.76 mm) thick, and shall provide not less than two full threads in the metal for the binding screw.

Exception No. 1: Two full threads are not required if a lesser number of threads results in a secure connection in which the threads do not strip when subjected to the tests and requirements of Security of Output Connector test in Section 45 of the Standard for Class 2 Power Units, UL 1310.

Exception No. 2: A plate may be less than 0.030 in (0.76 mm) thick if the tapped threads have acceptable mechanical strength as determined by the Security of Output Connector test in Section 45 of the Standard for Class 2 Power Units, UL 1310.

Exception No. 3: This requirement does not apply to a terminal plate that complies with the Exception to 45.1 of the Standard for Class 2 Power Units, UL 1310.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

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

7.6.3.3 Terminal studs shall be prevented from turning by means other than friction between mounting surfaces. The acceptability of a lock washer or similar means to prevent turning shall be determined by the Security of Output Connector test in Section 45 of the Standard for Class 2 Power Units, UL 1310.

7.6.4 Push-in type terminals

7.6.4.1 A push-in (screw less) field wiring terminal (one in which a stripped copper conductor is inserted and automatically locked in a wire entrance hole) meets the intent of providing a current-carrying connection if it complies with the following tests:

a) Pullout Test, Section 40.1, in the Standard for Fluorescent-Lamp Ballasts, UL 935.

b) Temperature Test, Section 40.2, in the Standard for Fluorescent-Lamp Ballasts, UL 935.

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

7.6.4.3 A push-in type field wiring supply terminal shall be provided with a 3/8 in (9.5 mm) minimum clearance and creepage distance measured from the recessed contact to accessible dead conductive part.

7.6.4.4 A power source that employs push-in (screwless) terminals shall be marked with 12.2.3.

7.6.5 Output connectors

7.6.5.1 A unit with multiple supply or load connections and where interconnection exceeds Class 2 levels as defined in this standard shall be provided with a polarized connector.

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

7.6.5.3 Connectors normally used with coaxial cable shall not be used for output connections.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.7 Separation of circuits

7.7.1 Power limited wiring and branch circuit wiring that come in random contact within the unit shall have insulation rated for the maximum voltage that exists in any of the circuits or shall be permanently and reliably segregated a minimum of 0.25 in (6.44 mm) to prevent contact.

7.7.2 Segregation of insulated conductors may be accomplished by clamping, routing, a barrier, or equivalent means that provides permanent separation from an insulated or uninsulated live part of a different circuit.

7.7.3 A barrier used to separate or segregate internal wiring shall have mechanical strength and be held in place to provide permanent separation, and it shall be acceptable for the temperatures involved.

7.7.4 A barrier intended to separate or segregate accessible Class 2 wiring from line-voltage parts shall be of material of sufficient thickness to serve its intended purpose. The barrier shall be supported so that its deformation cannot be readily accomplished to defeat its purpose.

7.8 Insulating materials

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

7.8.2 An insulating material is to be evaluated for the application in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C with respect to:

a) Mechanical strength,

b) Resistance to ignition sources,

c) Dielectric strength,

d) Insulation resistance,

e) Heat-resistant properties in both the aged and unaged conditions,

f) The degree to which it is enclosed,

g) Resistance to moisture if the unit is other than rated for dry locations, and

h) Any other features affecting the risk of fire and electric shock.

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

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.9 Printed wiring boards

7.9.1 A printed wiring board shall be intended for the application. The criteria shall include:

a) The bonding of the foil to the substrate for the minimum conductor width and maximum unpierced area as required by the Standard for Printed Wiring Boards, UL 796;

Exception: Printed wiring boards that are completely encased in potting compound or conformal coating are not required to additionally comply with UL 796.

b) The temperatures measured in the Normal Operations Temperature Test, Section 10.3, shall be less than the temperature rating (RTI) of the substrate as determined by the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B; and

c) The flammability of the printed wiring board substrate shall be no less than V-1 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts and Appliances, UL 94. material or has an equivalent barrier.

7.9.2 For an uncoated printed-wiring board, the minimum spacing between adjacent foil traces shall be at least as specified in Table 7.1. For printed wiring boards that are covered with potting compound or a conformal coating, the minimum spacing between the adjacent foil traces prior to coating shall be as specified in the first row of Table 7.1.

Exception No. 1: When the power available between two insulated parts is less than 50 W when determined in accordance with Section 29.6, UL 935, the spacing is not required to comply with this requirement.

Exception No. 2: The minimum spacing is determined by the dielectric voltage withstand test described in 10.4.4(c).

7.9.3 Where a conformal coating is used as described in 7.9.2, the conformal coating shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C and be suitable for use in combination with the printed wiring board.

7.9.4 For components mounted along the edge of a printed wiring board, clearances between uninsulated parts of opposite polarity and uninsulated live parts and a dead conductive part that is able to be grounded or a metal part exposed to contact by persons are to take into consideration the possible movement of the component and the printed wiring board itself. When applying the limits in Table 7.1, the printed wiring board is positioned, when movement is possible, in the direction that yields the smallest clearance between the parts in question.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.10 Spacing of electrical parts

7.10.1 The clearances (through air) and creepage distances (over surface of insulating material) between:

a) Uninsulated live parts of opposite polarity, and;

b) Uninsulated live and dead conductive parts likely to become energized,

shall comply with the spacing requirements in Table 7.1.

Table 7.1
Spacing for dry, damp, and wet locations

Locations	Maximum voltage between parts, Vrms (Vpeak=1.4 Vrms) [clearance/creepage distance]								
	50	150	300	450	600	750	900	1050	1200
	Dimensions in inches (millimeters)								
Parts potted or subsequently coated	-/0.007[a] (-/0.18[a])	-/0.012[a] (-/0.3[a])	-/0.027 (-/0.7)	-/0.031 (-/0.8)	-/0.031 (-/0.8)	-/0.063 (-/1.6)	-/0.094 (-/2.4)	-/0.126 (-/3.2)	-/0.165 (-/4.2)
For Dry and Damp Locations: Live parts reliably positioned AND insulator CTI ≥ 600 (PLC=0); example: lead wires of a transistor or diode to its mounting[c]	0.008/ 0.024 (0.2/ 0.6)	0.020/ 0.031 (0.5/ 0.8)	0.059/ 0.059 (1.5/ 1.5)	-/0.089 (-/2.25)	0.118/ 0.118 (3.0/ 3.0)	-/0.148 (-/3.75)	-/0.177 (-/4.5)	-/0.228 (-/5.8)	-/0.236 (-/6.0)
For Dry and Damp Locations: Live parts reliably positioned AND insulator CTI < 600 (PLC=3 or 4); examples: adjacent foils on printed wiring board or lead wires of a transistor or diode to its mounting[d]	0.008/ 0.047 (0.2/ 1.2)	0.020/ 0.063 (0.5/ 1.6)	0.059/ 0.118 (1.5/ 3.0)	0.089/ 0.177 (2.25/ 4.5)	0.118/ 0.240 (3.0/ 6.1)	-/0.295 (-/7.5)	-/0.354 (-/9.0)	-/0.413 (-/10.5)	-/.472 (-/12.0)
For Wet Locations: Live parts reliably positioned AND insulator CTI ≥ 600 (PLC=0); example: lead wires of a transistor or diode to its mounting[e]	0.008/ 0.059 (0.2/ 1.5)	0.020/ 0.079 (0.5/ 2.0)	0.059/ 0.146 (1.5/ 3.7)	-/0.220 (-/5.6)	0.118/ 0.295 (3.0/ 7.5)	-/0.374 (-/9.5)	-/0.449 (-/11.4)	-/0.524 (-/13.3)	-/0.598 (-/15.2)
For Wet Locations: Live parts reliably positioned AND insulator CTI < 600 (PLC=3 or 4); examples: adjacent foils on printed wiring board or lead wires of a transistor or diode to its mounting[f]	0.008/ 0.075 (0.2/ 1.9)	0.020/ 0.106 (0.5/ 2.7)	0.059/ 0.185 (1.5/ 4.7)	-/0.280 (-/7.1)	0.118/ 0.374 (3.0/ 9.5)	-/0.469 (-/11.9)	-/0.563 (-/14.3)	-/0.657 (-/16.7)	-/0.748 (-/19.0)
Parts on printed wiring boards that are soldered in place but can move in production prior to soldering to fixed parts or parts on printed wiring board to enclosure where enclosure and can deflect.[g]		0.118/- (3.0/-)	0.154/- (3.9/-)	0.185/- (4.7/-)	0.220/- (5.6/-)	0.256/- (6.5/-)	0.291/- (7.4/-)	0.323/- (8.2/-)	
Live parts and dead conductive parts in a conventional magnetic device construction where the coil size can vary due to random wind OR where coil assembly placement can vary in production.	0.126/ 0.252 (3.2/ 6.4)	0.126/ 0.252 (3.2/ 6.4)	0.252/ 0.374 (6.4/ 9.5)	0.252/ 0.374 (6.4/ 9.5)	0.374/ 0.374 (9.5/ 9.5)	0.374/ 0.374 (9.5/ 9.5)	0.374/ 0.374 (9.5/ 9.5)	0.374/ 0.500[b] (9.5/ 12.7[b])	0.374/ 0.500[b] (9.5/ 12.7[b])
Field wiring terminals to each other and fixed live or dead conductive parts	Not defined	0.252/ 0.252 (6.4/ 6.4)	0.252/ 0.374 (6.4/ 9.5)	0.374/ 0.374 (9.5/ 9.5)	0.374/ 0.374 (9.5/ 9.5)	0.374/ 0.492 (9.5/ 12.5)	0.374/ 0.492 (9.5/ 12.5)	9.5/12.5	0.374/ 0.492 (9.5/ 12.5)
[a] Or as determined from the investigation of the Conformal Coating, whichever is greater.									

Table 7.1 Continued on Next Page

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669, 1/17/2007 - 4:22 AM
UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Table 7.1 Continued

Locations	Maximum voltage between parts, Vrms (Vpeak=1.4 Vrms) [clearance/creepage distance]								
	50	150	300	450	600	750	900	1050	1200
	Dimensions in inches (millimeters)								

[b] When the insulating material involved is not readily carbonized – for example, porcelain or urea-formaldehyde porcelain – the minimum required creepage distance is 0.374 in (9.5 mm).

[c] Other dimensions of creepage distance calculated by the following for voltage less than or equal to 160 V:

D = 0.002V + 0.5

and the following formula for voltages greater than 160 V:

D = 0.005V + 0.007

in which D is distance and V is volts.

[d] Other dimensions of creepage distance calculated by the following for voltages less than or equal to 160 V:

D = 0.004V + 0.976

and the following formula for voltages greater than 160 V:

D = 0.01V

in which D is distance and V is volts.

[e] Other dimensions of creepage distance calculated by the following formula for voltage less than or equal to 160 V:

D = 0.005V + 1.26

and the following formula for voltages greater than 160 V:

D = 0.126V

in which D is distance and V is volts.

[f] Other dimensions of creepage distance calculated by the following formula for voltage less than or equal to 160 V:

D = 0.0057V + 1.61

and the following formula for voltages greater than 160 V:

D = 0.016V

in which D is distance and V is volts.

[g] Other dimensions of clearance calculated by the following formula for voltages between 150 and 1050 V:

D = 0.0059V + 2.09

in which D is distance and V is volts.

7.10.2 As an alternative to the spacing requirements of Table 7.1, the spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances For Electrical Equipment, UL 840, may be used.

Note: Table 7.1 summarizes the spacing requirements from UL 840 that are typically applied to power sources and LED modules.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
E27669 : 10/17/2007 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.10.3 The spacing requirements of the Standard for Insulation Coordination Including Clearances and Creepage Distances For Electrical Equipment, UL 840 shall not be used for field wiring terminals, output wiring terminals and spacings to a dead conductive enclosure.

7.10.4 At other than field-wiring terminals, spacings from the transformer secondary winding on or beyond the energy-limiting component, as may be appropriate, in a power limited Class 2 or LPS secondary circuit between live parts of opposite polarity and between a live part and a dead conductive part are not specified.

7.10.5 Creepage distances shall not be less than clearances.

7.10.6 When using the requirements specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances For Electrical Equipment, UL 840, to determine clearances, a unit connected to the supply circuit is judged as an over voltage category II.

7.10.7 Printed wiring boards constructed of Types XXXP, XXXPC, G 10, FR 2, FR 3, FR 4, FR 5, CEM 1, CEM 3, GPO 2, or GPO 3 industrial laminates in accordance with the Standard for Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fiber, and Materials Used in Printed Wiring Boards, UL 746E, are identified to have a minimum comparative tracking index (CTI) of 100 [PLC=4] without further investigation.

7.11 Circuit components

7.11.1 A component – a fixed resistor, Positive Temperature Coefficient (PTC) or Negative Temperature Coefficient (NTC) resistor, semiconductor, or the like – employed to limit the output of a unit to within the required current or power levels, or otherwise used to obtain acceptable performance, shall have permanence and stability which does not decrease its limiting capacities. Among the factors considered when evaluating a limiting component are:

a) Effect of operating temperature;

b) Electrical stress level;

c) Effect of transient surges; and

d) Resistance to moisture.

7.11.2 A thermistor, Positive Temperature Coefficient (PTC) or Negative Temperature Coefficient (NTC) resistance, provided to limit the output of a unit to within the required current or power levels, or with maximum temperature requirements or otherwise used to obtain acceptable test results shall have a Calibration Class of C1 or C2.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

7.12 Protective devices

7.12.1 A protective device built into a unit shall comply with the requirements for that component.

7.12.2 A protective device may be located in either a primary or secondary circuit.

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

7.12.4 Protective devices mentioned in 7.12.1 include, but are not limited to, eutectic material, fuses, over temperature and over current protectors, thermal protectors, and similar devices intended to interrupt or limit the flow of current as a result of overload.

7.12.5 A thermostat, thermal cutoff, Positive Temperature Coefficient (PTC) thermistor, or Negative Temperature Coefficient (NTC) thermistor incorporated in a unit shall not cause a risk of fire or electric shock due to improper application.

7.12.6 An automatically or manually reset protective device or a replaceable over current-protective device shall not open when the unit is delivering its rated output. See the Normal Temperature Test, Section 10.

7.12.7 A primary circuit over current protective device of the single-pole type, other than an automatic control without a marked ″off″ position, shall be connected to an ungrounded circuit conductor.

7.12.8 When a single protective device is located in the primary circuit, it shall be connected to the ungrounded circuit conductor.

7.12.9 When both circuit conductors of a product intended for connection to a nominal 120 V branch circuit are fused, the fuse in the grounded circuit conductor shall be rated not less than the fuse in the ungrounded circuit conductor.

7.12.10 An over current protective device shall be located inside the unit enclosure. The device shall be inaccessible to tampering.

Exception: A unit may be provided with an externally replaceable over current protective device. If the device is relied upon for acceptable performance, the device shall not be interchangeable with a device having a higher current rating.

7.12.11 The fuse type identification and ampere rating shall be marked on or adjacent to a user serviceable fuse or fuse holder. See 12.2.4 (f) for wording.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

8 LED Power Source

8.1 General

8.1.1 The requirements in Section 8 are supplementary to other applicable requirements in this outline.

8.1.2 A power source is required to operate within its rated input and output ratings.

8.1.3 A power source without an integral enclosure shall be enclosed in an electrical enclosure that complies with the enclosure requirements of the end product standard.

8.1.4 A power source may have more than one Class 2 or LPS output.

8.1.5 A power source shall be designated as one of the options described in Table 8.1.

Table 8.1
Power Supply Output Designations

Power Source Type	Power Supply Output Designations		
	Output < Class 2 or LPS Limits	Output < SELV Limits	Output > Class 2 or LPS or SELV
Isolated – Output electrically insulated from the input	Type 2-I	Type F-I	Type FS-I
Direct Connected – Output not electrically insulated from the input	NA	Type F-D	Type FS-D
I = Insulated output, F = Risk of fire, S = Risk of shock, NA = Not Applicable			

8.2 Power source enclosure

8.2.1 The requirements in 8.2 supplement the applicable requirements in 6.1, 6.2 and 6.3 of this outline.

8.2.2 A polymeric material, thermoplastic or thermosetting, used to provide all or part of the enclosure for electrical parts of a power source as specified in 6.1.2 shall also comply with the requirements of this section. Table 8.2 summarizes the specific requirements regarding use of a polymeric material as an enclosure.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Table 8.2
Summarized Enclosure Requirements LED Power Source

	Power Source with fixed mounting and no hazardous live parts within 0.8 mm of the enclosure	Power Source with fixed mounting and having hazardous live parts within 0.8 mm of the enclosure	Cord connected or direct plug-in Power Source with no hazardous live parts within 0.8 mm of the enclosure	Cord connected or direct plug-in Power Source having hazardous live parts within 0.8 mm of the enclosure
Relative Thermal Index (RTI)	See 6.3.2	See 6.3.2	See 6.3.2	See 6.3.2
Impact – 5 ft-lb at room temperature	Yes	Yes	No	No
Impact – 3 ft drop at room temperature	No	No	Yes	Yes
Impact – 5 ft-lb pre-conditioning at 0°C for damp locations and -35°C for wet locations	Yes – when wet locations rated	Yes – when wet locations rated	No	No
Mold Stress Relief	Yes	Yes	Yes	Yes
UV Stability	Yes – when wet locations rated	Yes – when wet locations rated	No	No
Minimum Flame Resistance	5VA	5VA	V1	V1
Comparative Tracking Index	Not Applicable	PLC = 4 or less (more resistant)	Not Applicable	PLC = 4 or less (more resistant)
Hot Wire Ignition	Not Applicable	PLC = 3 or less (more resistant)	Not Applicable	PLC = 3 or less (more resistant)
High Ampere Arc	Not Applicable	PLC = 2 or less (more resistant	Not Applicable	PLC = 2 or less (more resistant
Note – This table is a summary of the requirements contained in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and therefore shall not be identified as complete. Additional considerations are specified in UL 746C.				

8.2.3 In applying the requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, a power source hard-wired to a branch circuit is considered permanently connected equipment. A power source with a cord or a direct-plug in power source is evaluated as portable, non-attended equipment.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM
UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

8.3 Power supplies

8.3.1 General

8.3.1.1 A power supply evaluated to one of the specified standards need only be evaluated to determine compliance with any applicable supplemental requirements specified in this outline of investigation:

a) The Standard for Class 2 Power Units, UL 1310;

b) The Standard for Information Technology Equipment, UL 60950; or

c) The Standard for Power Units Other Than Class 2, UL 1012.

8.3.2 Plug and cord connected

8.3.2.1 Direct plug in or through cord style power supplies marked ″Indoor Use″ are suitable for portable lighting equipment only.

8.3.2.2 Direct plug in or through cord style power supplies marked for ″I.T.E. Use Only″ are suitable for portable lighting equipment only. I.T.E. denotes Information Technology Equipment.

8.3.2.3 The component parts of the LED light source connected to the output of a direct plug in or through cord style power supply marked ″Class 2″ or limited power source (LPS) shall not be required to be within an electrical enclosure.

8.3.3 Permanently wired

8.3.3.1 LED modules and control circuits connected to SELV or ELV outputs of a power supply complying with the requirements in the Standard for Safety of Information Technology Equipment, UL 60950, and that exceeds risk of fire limits, are to have the secondary circuits wired as Class 1 circuits.

8.3.3.2 LED modules and control circuits connected to the output of power supplies complying with the requirements in the Standard for Safety of Information Technology Equipment, UL 60950, and having secondary circuits that are ″LPS″ shall be wired as Class 2 circuits.

8.3.3.3 Power supplies evaluated for use in Pollution Degree 2 environments are restricted to indoor or dry location lighting products.

8.3.3.4 A Pollution Degree 2 evaluated power supply that is completely conformal coated or potted may be used in a damp, wet, or outdoor lighting product.

8.3.3.5 A Pollution Degree 2 evaluated power supply installed in an enclosure equivalent to a NEMA Type 3, 3S, or 4X enclosure may be used in a damp, wet, or outdoor lighting product.

8.3.3.6 A Pollution Degree 3 evaluated power supply installed in an enclosure equivalent to a NEMA Type 3R enclosure or an enclosure meeting the wet locations requirements of the end product standard may be used in a wet or outdoor lighting product.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 : 9:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

8.4 Transformers

8.4.1 A transformer evaluated to one of the specified standards need only be evaluated to determine compliance with any applicable supplemental requirements specified in this outline of investigation:

a) The Standard for Class 2 and Class 3 transformers, UL 1585;

b) The Standard for Transformer and Motor Transformers for Use in Audio-, Radio- and Television-type Appliances, UL 1411;

c) The Standard for Specialty Transformers, UL 506; or

d) The Standard for Dry-Type and General Purpose Power Transformers, UL 1561.

8.4.2 A transformer shall be required to operate within its rated input and output ratings.

9 LED and Control Modules

9.1 General

9.1.1 The requirements in Section 9 are supplementary to other applicable requirements in this outline.

9.1.2 LED modules and control modules supplied by power limited Class 2 or LPS qualified circuits are not required to be enclosed.

9.2 Enclosures

9.2.1 The requirements in 9.2 supplement other applicable requirements in 6.1, 6.2 and 6.3 of this outline.

9.2.2 A polymeric material, thermoplastic or thermosetting, used to fabricate an enclosure as specified in 6.1.2 for electrical parts of a LED or Control module shall also comply with the requirements of this section. Table 9.1 summarizes the specific requirements regarding use of a polymeric material as an enclosure.

Table 9.1
Summarized Enclosure Requirements LED Module and Control Module

Power Source	Power Supply Type				
	Type 2-I	Type 2-D		Type F-I, F-D, FS-I or FS-D	
LED Module or Control Module Required to be Enclosed?	No	Yes		Yes	
Spacings to arcing or live parts	Not Applicable	No hazardous live parts within 0.8 mm of the enclosure	Hazardous live parts within 0.8 mm of the enclosure	No hazardous live parts within 0.8 mm of the enclosure	Hazardous live parts within 0.8 mm of the enclosure
Relative Thermal Index (RTI)	Not Applicable	See 6.3.2	See 6.3.2	See 6.3.2	See 6.3.2
Impact – 5 ft-lb at room temperature	Not Applicable	Yes – Fixed / stationery and dry / damp locations rated	Yes – Fixed / stationery and dry / damp locations rated	Yes – Fixed / stationery and dry / damp locations rated	Yes – Fixed / stationery and dry / damp locations rated

Table 9.1 Continued on Next Page

Document was downloaded By jordan jordan
For Use By RICHFIELD LOGIC PRODUCTS LTD
UL 27669 - 10/17/2007 - 4:01 AM
UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

Table 9.1 Continued

Power Source	Power Supply Type				
	Type 2-I	Type 2-D		Type F-I, F-D, FS-I or FS-D	
Impact – 3 ft drop at room temperature	Not Applicable	Yes – Portable	Yes – Portable	Yes – Portable	Yes – Portable
Impact – 5 ft-lb pre-conditioning at 0°C for damp locations and -35°C for wet locations	Not Applicable	Yes – Fixed / stationery and wet locations rated	Yes – Fixed / stationery and wet locations rated	Yes – Fixed / stationery and wet locations rated	Yes – Fixed / stationery and wet locations rated
Mold Stress Relief	Not Applicable	Yes	Yes	Yes	Yes
UV Stability	Not Applicable	Yes – when wet locations rated	Yes – when wet locations rated	Yes – when wet locations rated	Yes – when wet locations rated
Minimum Flame Resistance	Not Applicable	V1	V1	5VA	5VA
Comparative Tracking Index	Not Applicable	Not Applicable	PLC = 5 or less (more resistant)	Not Applicable	PLC = 4 or less (more resistant)
Hot Wire Ignition	Not Applicable	Not Applicable	Not Applicable	Not Applicable	PLC = 3 or less (more resistant)
High Ampere Arc	Not Applicable	Not Applicable	Not Applicable	Not Applicable	PLC = 2 or less (more resistant)

9.3 Enclosure openings

9.3.1 Ventilation openings shall be permitted in any surface of the electrical enclosure of a control module.

9.3.2 The major dimensions of a ventilating opening shall prevent the articulated probe with web stop as shown in the Standard for Luminaires, UL 1598 from contacting uninsulated live parts or magnet wire.

9.3.3 Uninsulated live parts and components in power limited Class 2, LPS or SELV qualified circuits are permitted to be accessible.

9.3.4 Ventilation openings that permit line of sight to open core and coil components shall be louvered or baffled.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

9.4 Conditions of use for component LED and control circuit modules

9.4.1 The conditions of use shall be specified for an LED or control circuit module intended for factory installation in an end product. Typical locations of use include installation in dry, damp or wet locations.

9.4.2 Suitability of rain enclosure shall be determined if intended for wet location.

9.4.3 Mounting position shall be specified if the enclosure has ventilation openings.

9.4.4 The limits of the power source each LED module or control circuit module is designed to be connected to.

9.4.5 Suitability of electrical enclosure and secondary wiring shall be determined if single circuit power requirements exceed Class 2 or LPS limits.

PERFORMANCE

10 Performance Tests

10.1 General

10.1.1 All electrical measurements, unless otherwise specified, are to be conducted:

a) In a draft-free room,

b) At an ambient temperature of 25°C + 5°C unless a higher ambient temperature is specified by the manufacturer, and

c) With the unit connected to a source of supply nominal supply of rated frequency that is adjusted to within 5 percent of the marked rated voltage.

Unless the manufacturer indicates the most critical combination, all combinations (min./max.) of voltage/current and temperature shall be tested.

10.2 Input test

10.2.1 The input current shall not exceed 110 percent of the units rating when operated at rated voltage.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

10.3 LED module normal operations temperature test

10.3.1 An LED power source, LED module and an LED control module are to be tested in accordance with the Normal Temperature test requirements specified in the intended end product standard.

10.3.2 Temperatures resulting from the normal temperature test shall not exceed the limits specified in the respective end product standard, unless the component, material, or compound has been investigated and found acceptable for a higher temperature.

10.3.3 The device shall comply with the requirements of the dielectric voltage-withstand test of Section 10.4 immediately after the normal temperature test.

10.4 Dielectric voltage withstand test

10.4.1 The test potential specified in 10.4.4(a) and (b), as applicable, is to be applied to power sources, LED modules and control circuit modules connected directly to the branch circuit.

10.4.2 The test potential specified in 10.4.4(b) is to be applied to LED modules and control circuit modules connected to the output of a Type F-I, F-D, FS-I or FS-D power source.

10.4.3 This test is not required for LED modules and control circuit modules connected to the output of a Type 2-I or 2-D power source.

10.4.4 One minute after the applicable test, the unit shall withstand for 1 min without breakdown the application of a potential. The test potential shall be:

a) One thousand volts ac plus twice the maximum rated voltage between:

1) The primary circuit and accessible dead conductive parts; and

2) The transformer primary and secondary circuit or circuits.

b) Five hundred volts ac between a transformer secondary circuit and dead conductive parts.

c) A dc potential of 1.414 times (2 V + 1000), where V is the rms supply voltage, between the PWB foil traces, or the terminals of a capacitor used for radio-interference elimination or arc suppression.

Exception: If an ac potential results in excessive leakage through capacitors during the test specified in (a) and (b), the capacitors are to be removed from the circuit for the ac potential. With the capacitors connected in the circuit, the unit shall withstand a dc potential of 1.414 times the ac rms potential between the points specified.

10.4.5 To determine if a unit complies with the requirements in 10.4, it is to be tested by means of a transformer of 500-VA capacity or larger, having an output voltage that is essentially sinusoidal or continuous direct current, as applicable, and can be varied. The applied potential is to be increased from zero until the required test level is reached, and is to be held at that level for 1 min. The increase in applied potential is to be at a substantially uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

Exception: A 500 VA or larger capacity transformer need not be used if the transformer is provided with a voltmeter to measure directly the applied output potential.

Document Was Downloaded By jordan jordan
For Use By RICHMOND HOMES PRODUCTS LTD
27609 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

11 Abnormal Tests

11.1 General

11.1.1 A unit shall not emit flame or molten metal or become a risk of fire or electric shock when subjected to the following tests: output loading, reverse polarity, switch position, component breakdown, and when required, the printed wiring board abnormal operation test. Each abnormal test shall be followed by a dielectric voltage withstand test as required by 10.4.4(a).

11.1.2 A risk of fire or electric shock is considered to exist if any of the following occur:

a) Opening of the grounding fuse;

b) Charring of cheesecloth;

c) Emission of flame or molten material from the unit enclosure and output cord, if provided;

d) Any condition that exposes live parts that poses a risk of electric shock as specified in Accessibility of Hazardous Live Parts, Section 7.2;

e) Indication of dielectric breakdown;

f) For a direct plug-in unit, loss of structural integrity to a degree where the unit cannot be removed from a receptacle immediately after the test without deformation or a risk of electric shock; or

g) Opening of the branch-circuit over current protective device.

11.1.3 Each test is to be conducted on a separate sample unless the manufacturer requests that more than one test be conducted on the same sample.

11.1.4 During each test, the grounding means, if provided, is to be connected to ground through a 3-A non-time delay fuse.

11.1.5 A polarity-protection circuit provided to reduce the likelihood of output-current flow until a battery is connected as intended to the output is to be made inoperative so that the required output current will flow.

11.1.6 During all abnormal tests, the unit is to be draped with a double layer of cheesecloth conforming to the outline of the unit.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

11.2 Unreliable component abnormal test

11.2.1 The unit is to be energized at rated input voltage and frequency. The supply circuit is to be connected in series with a 20 A fuse (time delay type), of which the characteristics are such that the fuse does not open in less than 12 s when carrying 40 A. The unit is to be tested as described in 11.2.2.

11.2.2 Any electrolytic capacitor or semiconductor junction located in a circuit capable of delivering 50 W or more of power to an external resistor for 1 min, as determined in accordance with 11.3, is to be short circuited or open circuited. The fault conditions are to be introduced one at a time and not necessarily in the order indicated, and are to be applied throughout each complete test.

11.2.3 Regarding the ambient temperature of the device under test as described in 11.2.1, the intent of this requirement is met when the test condition operates in an ambient temperature of 25°C ±5°C (77°F ±5°F) until:

a) It is obvious within 30 min that a component has opened and the unit is no longer operable; or

b) The test is to continue until the ultimate result is known, and not exceeding 7 h.

11.2.4 Opening of the 20-A supply circuit fuse as a result of the particular component fault condition signifies compliance.

11.3 50-W point power measurement test

11.3.1 When it is not obvious what the power available is at various points in the circuit, a wattmeter and an adjustable external load resistor are to be arranged as illustrated in Figure 27.1, in the Standard for Fluorescent-Lamp Ballasts, UL 935, to determine the maximum power transfer.

11.3.2 The external load resistor is set for its maximum resistance. After the connection is made, and when there is no protective device in the unit, the adjustable resistance is to be reduced gradually to the point of maximum wattage as indicated by a peak reading on the wattmeter.

11.3.3 When a circuit component opens in less than 1 min effectively limiting the available power to less than 50 W or when the circuit inherently limits the current, the point is not capable of delivering 50 W for 1 min.

11.3.4 When there is a protective device in the unit, a closed shorting switch is to be connected across the protector, and the resistor is then to be adjusted to result in a power dissipation of exactly 50 W as indicated by the meter. The switch across the protective device is then to be opened and the time required for the protective device to open is to be recorded. When the protective device opens the circuit in less than 60 s, the point is not capable of delivering 50 W for 1 min.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

MARKINGS

12 Markings

12.1 General

12.1.1 A marking shall be legible and use one or more of the following methods:

a) Lettering on a pressure-sensitive label,

b) Paint stenciled lettering,

c) Ink-stamped machine lettering,

d) Ink-hand-stamped lettering,

e) Indelibly printed lettering,

f) Die-stamped lettering,

g) Embossed lettering, or

h) Molded or cast lettering.

12.1.2 The characters of embossed, molded, or cast lettering, either raised or recessed, shall be a minimum of 0.010 in (0.25 mm) in depth.

12.1.3 The characters shall be of lettering that is at least 0.062 in (1.6 mm) in height and upper case Univers bold, Arial bold, Helvetica bold, Zurich BT Bold font typeface.

12.1.4 Pressure-sensitive labels and nameplates of the permanent type that are secured by adhesive shall comply with the Standard for Marking and Labeling Systems, UL 969.

12.1.5 The adhesive of pressure-sensitive labels and nameplates of the permanent type shall be suitable for the mounting surface material and temperature involved, and the environment to which it will be subjected.

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

12.2 Required markings

12.2.1 A power source shall comply with the marking requirements specified in the standard it is evaluated to.

12.2.2 The output terminals of a power source shall be marked with the appropriate power source type from Table 8.1.

12.2.3 A power source that employs push-in (screwless) terminals shall be marked with instructions that are readily visible during installation:

a) For releasing the wire from the terminal connection;

b) That specify the intended wire gage;

c) That specify use with ″solid copper wire only″ unless the terminal is intended for both solid and stranded wire;

d) To strip the insulation from conductors a specified length;

e) For connecting acceptably sized wire; and

f) That specifies the terminal positions related to lamp connections.

12.2.4 A control module or LED module shall bear the following markings:

a) Company name;

b) Model designation;

c) Factory Identification – A component produced or assembled at more than one factory shall have a distinctive marking, which may be in code, by which it is able to be identified as manufactured at a particular factory;

d) Date of manufacture;

e) Input, volt and amps;

f) Fuse Replacement Marking – the fuse type identification and ampere rating shall be marked on, or adjacent to, the fuse and fuse holder. Wording shall be equivalent to the following:

″FUSE [identification]_____AMPS″

g) Electrical enclosures shall be marked for installation in dry, damp, or wet locations as determined by investigation. Enclosures identified as Type 3, 3R, 3S, or 4X are suitable for wet location and may be so marked;

h) A power source shall be marked with the appropriate output designation as specified in Table 8.1;

i) The appropriate input power source type from Table 8.1.

Document Was Downloaded By jordan jordan For Use By RICHFIELD HOME PRODUCTS LTD 27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

12.2.5 A unit with an enclosure shall bear a visible permanent marking that specifies the intended use environment with one of the following:

a) ″Dry locations only,″

b) ″Suitable for Damp locations,″ or

c) ″Suitable for Wet locations.″

12.2.6 A unit without an enclosure shall bear a visible marking that specifies the intended use environment with one of the following:

a) ″Dry locations only,″

b) ″Damp locations,″ or

c) ″Wet locations.″

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

No Text on This Page

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

APPENDIX A

Standards for Components

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

Title of Standard − UL Standard Designation

Attachment Plugs and Receptacles – UL 498
Capacitors – UL 810
Component Connectors for Use in Data, Signal, Control and Power Applications – UL 1977
Cords and Cables, Flexible – UL 62
Cord Sets and Power Supply Cords – UL 817
Electrical Quick-Connect Terminals – UL 310
Extruded Insulating Tubing – UL 224
Fuseholders – UL 512
Lampholders – UL 496
Marking and Labeling Systems – UL 969
Polymeric Materials – Fabricated Parts – UL 746D
Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used In Printed- Wiring Boards – UL 746E
Polymeric Materials – Long Term Property Evaluations – UL 746B
Polymeric Materials – Short Term Property Evaluations – UL 746A
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Power Units Other Than Class 2 – UL 1012
Power Units, Class 2 – UL 1310
Printed-Wiring Boards – UL 796
Protectors for Use in Electrical Equipment, Supplementary – UL 1077
Switches for Lighting Control, Nonindustrial Photoelectric – UL 773A
Switches, Special Use – UL 1054
Systems of Insulating Materials – General – UL 1446
Temperature-Indicating and -Regulating Equipment – UL 873
Terminal Blocks – UL 1059
Thermal-Links – Requirements and Application Guide – UL 60691
Thermistor-Type Devices – UL 1434
Transformers and Motor Transformers for Use in Audio-, Radio- and Television-Type Appliances – UL 1411
Transformers, Class 2 and Class 3 – UL 1585
Transformers, Specialty – UL 506
Wire Connectors – UL 486A-486B
Wires and Cables, Thermoplastic-Insulated – UL 83
Wiring Materials, Appliance – UL 758

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL

No Text on This Page

Document Was Downloaded By jordan jordan
For Use By RICHFIELD HOME PRODUCTS LTD
27669 : 10/17/2007 - 4:21 AM

UL COPYRIGHTED MATERIAL –
NOT AUTHORIZED FOR FURTHER REPRODUCTION OR
DISTRIBUTION WITHOUT PERMISSION FROM UL