Sales@Lisungroup.com | +8618117273997

Product Categories

Goniophotometer >
Spectroradiometer >
Integrating Sphere >
LED Test Instruments >
CFL Testing Instruments >
Photometer and Colorimeter >
EMI and EMC Test Systems >
Electronic Ballast Tester >
Electrical Safety Tester >
Environmental Test Chamber >
Plug and Switch Testing >
AC and DC Power Supply >
Object Color and Glossiness Test >
Mask Produce and Test Machine >
Electronic Components Test >

Adjustable High Frequency Reference Ballast

Product No: HCS-109A

Get a Quote

Your email address will not be published. Required fields are marked *

Name* Company*

Email* Cell/WhatsApp

Message*

Verify Code

Send

1

Description Download

1

Related Applications

Fluorescent Lamp Test Solutions

Sales@Lisungroup.com | +8618117273997

UL updated standard, using 25kHz High Frequency Reference Ballast to detect Type A LED tubes

How to Measure the High Frequency Fluorescent Lamp

HCS-109A Adjustable LED High Frequency Reference Ballast is for Type A LED Tube Test

Two test way for High Frequency Adjustable Reference Ballast (25KHz)

Related Successful Case

Austrilia and Indonesia – Installed goniophotometer, integrating sphere, surge generator and electrical safety test

Application:

• According to UL1993, HCS-109A is used to do input test, temperature rise test, leakage current test and harmonic distortion test for LED Type A tube direct replacement fluorescent tube.

• According to GB/T 10682-2002, UL1993-S and IEC 60081:1997, HCS-109A is used to test the high frequency fluorescent lamp such as T5 tube and power frequency fluorescent lamp such as T8/T12 tube. Please visit this page to learn more about How to Measure the High Frequency Fluorescent Lamp.

Specifications:

• Input voltage: 200V~240V, 50/60Hz

• Input Power: 80 W max

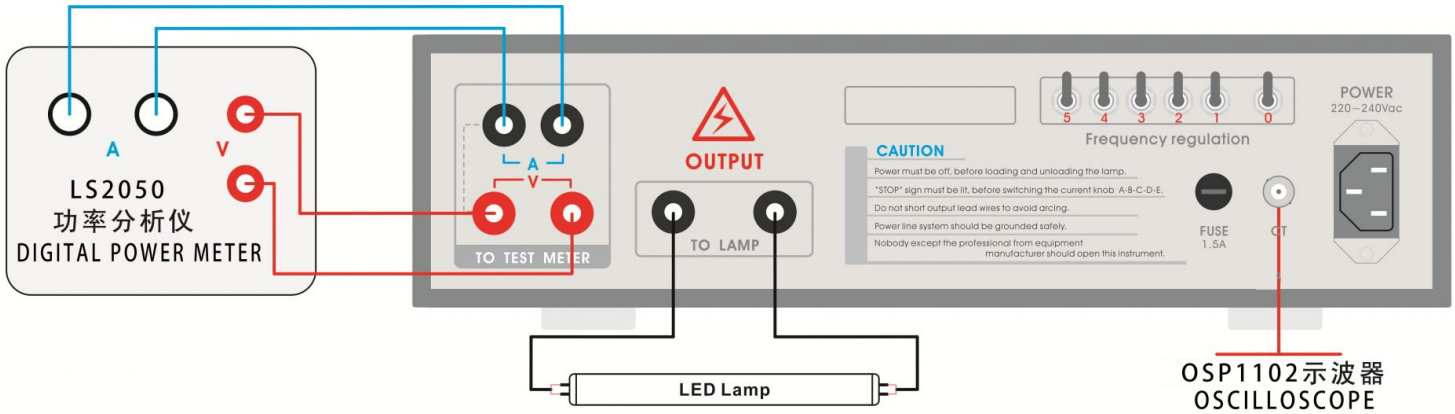
• Output Current: 130mA~400mA (Adjustable), accuracy: +/- 1%

• Output Frequency: 25kHz< +/-2.0% (Adjustable), accuracy: +/- 0.3kHz

• Output current total harmonic wave distortion: THD<2.5% (HF current wave)

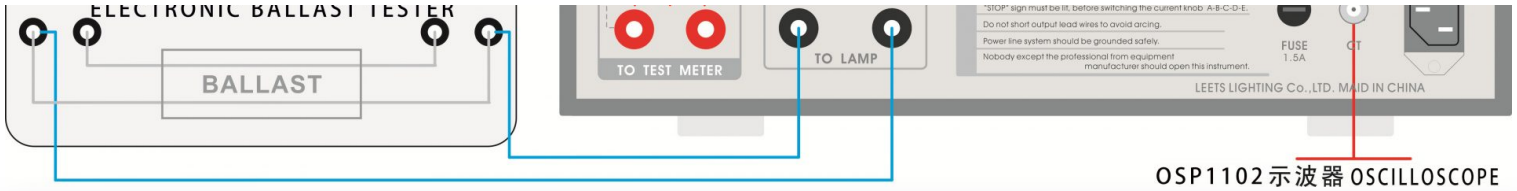
Test connection one:

It can be connect with LISUN’ s LS2050 High Accuracy Digital Power Meter and OSP1102 Digital Oscilloscope.



Test connection Two:

It can connect with LISUN’ s WT5000 Electronic Ballast Tester and OSP1102 Digital Oscilloscope.



Gurwinder Singh

2019-12-28

Good guy! Good service! Especially the free installation!

Tags：Adjustable High Frequency Reference Ballast , HCS-109A

UL 1993

STANDARD FOR SAFETY

Self-Ballasted Lamps and Lamp Adapters

UL Standard for Safety for Self-Ballasted Lamps and Lamp Adapters, UL 1993

Fourth Edition, Dated December 4, 2012

Summary of Topics

This new edition of ANSI/UL 1993, the harmonized ANCE, CSA, and UL Standard for Self-Ballasted Lamps and Lamp Adapters, includes the following major changes:

> ***a) Miscellaneous corrections and revised marking section; b) Clarify use of polymeric materials in 5.3.1; c) Change of end product requirement to material requirement in Clause 5.3.4; d) Change of material requirement to end product requirement in Clauses 5.3.6 and 8.9.2; e) Add requirements for screwshell metal of device bases for damp location applications; f) Clarification fusing resistors used for thermal protection; g) Clarification of insulation system requirement; h) Relocate qualifying requirements for humidity conditioning; i) Provide additional requirements for small coils for inductor thermal measurement method in temperature test; j) Delete subsequent testing by dielectric voltage withstand in 8.9.3; k) Temperature test fixture dimension correction; and l) Add Supplement A for Devices Using Light Emitting Diodes (LED)***

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated November 25, 2011 and July 6, 2012.

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 preface. 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.

The following table lists the future effective dates with the corresponding reference.

Future Effective Date	References
December 4, 2015	Clause 6.4.6

Association of Standardization and Certification
NMX-J-578/1-ANCE
Second Edition

CSA Group
CSA C22.2 No. 1993-12
Second Edition

Underwriters Laboratories Inc.
UL 1993
Fourth Edition

Self-Ballasted Lamps and Lamp Adapters

December 4, 2012

ANSI/UL 1993-2012

Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association operating as “CSA Group”, and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the procedures may be submitted to ANCE, CSA Group, or UL at any time. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA and UL pages.

ISBN 978-1-77139-166-5 © 2012 CSA Group

This standard is subject to periodic review, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include “Proposal for change” in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

To purchase CSA Group Standards and related publications, visit CSA Group’s Online Store at **shop.csa.ca** or call toll-free 1-800-463-6727 or 416-747-4044.

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

The most recent designation of ANSI/UL 1993 as an American National Standard (ANSI) occurred on December 4, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface, 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.

To purchase UL Standards, visit Comm 2000 at http://www.comm-2000.com/help/how_to_order.aspx or call toll-free 1-888-853-3503.

NOTE – The user’s attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights.

By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection there with. The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from UL.

No Text on This Page

CONTENTS

SUPPLEMENT SA - SUPPLEMENTAL REQUIREMENTS FOR LIGHT-EMITTING DIODES (LED)

ANNEX E (CAN) (normative) Printed Circuit Boards

ANNEX F (informative) Pictograms

ANNEX G (informative) Metric Conversion Information

Preface

This is the harmonized ANCE, CSA Group, and UL Standard for Self-Ballasted Lamps and Lamp Adapters. It is the second edition of NMX-J-578/1-ANCE, the second edition of CSA C22.2 No. 1993, and the fourth edition of UL 1993. This edition of CSA C22.2 No. 1993 replaces the Technical Information Letter TIL No. B-36B "Self-Ballasted Fluorescent Lamps with Medium Screw-Base and Integral-Ballasted Adapters with Medium Screw-Base for Fluorescent Lamps." This edition of UL 1993 supersedes the previous edition published in 2009.

The end-of-lamp-life tests for fluorescent lamp adapters material is reproduced from IEC 61347-2-3 with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission (IEC). No part of this material may be copied or reproduced in any form, electronic retrieval system or otherwise or made available on the Internet, a public network, by satellite or otherwise without the prior written consent of the American National Standards Institute. Copies of IEC standards may be purchased from the American National Standards Institute, 25 West 43rd Street, New York, NY 10036, (212) 642-4900, *http://webstore.ansi.org*.

This standard contains information copyright protected by the International Electrotechnical Commission (IEC). The end-of-lamp-life tests for fluorescent lamp adapters material is reproduced from IEC 61347-2-3 with permission from the Standards Council of Canada (SCC) in Canada on behalf of the International Electrotechnical Commission (IEC). Except as permitted under the laws of Canada, no extract of the International Standard may be reproduced, stored in any retrieval system, or transmitted in any form or by any means, electronic, photocopying, recording, or otherwise, without prior permission from the Standards Council of Canada (SCC).

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), the CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Self-Ballasted Lamps, of the Council of the Harmonization of Electrotechnical Standards for the Nations of the Americas (CANENA), are gratefully acknowledged.

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

This standard was reviewed by the CSA Subcommittee on Lighting Products, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

In Canada, for general information on the Standards of the Canadian Electrical Code, Part II, see the preface to CAN/CSA-C22.2 No. 0.

This standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

A UL standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

NOTE Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This standard is published as an equivalent standard for CSA Group and UL and a proposed equivalent standard for ANCE. An equivalent standard is a standard that is substantially the same in technical content, except as follows. Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

Interpretations

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

ANCE effective date

The effective date for ANCE will be announced through the *Diario Oficial de la Federation (Official Gazette)*.

CSA Group effective date

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

UL effective date

As of December 4, 2012, all products Listed or Recognized by UL must comply with the requirements in this standard except for clauses, figures, and tables in the following list, which are effective December 4, 2015.

Clause 6.4.6.

Between December 4, 2012 and December 4, 2015, new product submittals to UL may be evaluated under all requirements in this standard or, if requested in writing, evaluated under presently effective requirements only. The presently effective requirements are contained in the Third Edition of UL 1993.

A UL effective date is one established by Underwriters Laboratories Inc. and is not part of the ANSI approved standard.

1 Scope

1.1 These requirements are intended to cover both self-ballasted lamps and self-ballasted lamp adapters rated 120 to 347 V AC nominal for connection to screw-base, pin-base, or recessed single contact (RSC or R7) lampholders. These devices are intended for use in accordance with the National Electrical Code, ANSI/NFPA 70, and the Canadian Electrical Code, Part I, in non-hazardous locations, and the Instalaciones Eléctricas (utilización), NOM-001-SEDE.

1.2 These devices incorporate resistance, reactance, or electronic (solid-state) type ballasts or power supplies. These devices employ various lamp technologies including, but not limited to, incandescent, fluorescent, high-intensity discharge lamps, light-emitting diodes.

1.3 These requirements also include Supplemental Requirements for Light-Emitting Diodes (LED), Supplement SA, for:

a) Self-contained LED lamps, rated 120 to 347 V AC nominal for connection to screw-, pin-base, and recessed single contact (RSC or R7) lampholders,

b) Lamps for replacement of an ANSI standardized fluorescent lamp, and consisting of light-emitting-diode (LED) lamp technologies, with control circuitry, and a driver or power supply. The LED driver and control circuitry will be either integral with the lamp or remote from the lamp, and

c) Component LED lamps, with or without control circuitry, an ANSI base other than bases mentioned in (a), for connection to LED driver having a low voltage output, such as replacement for tungsten-halogen, MR11 and MR16 shaped lamps.

1.4 This standard does not apply to medium-to-medium base (E26) fittings that incorporate controls such as photocells, motion detectors, radio controls, or dimmers covered by other standards.

1.5 These devices are not intended for use with emergency exit fixtures or emergency exit lights.

2 Reference Publications

2.1 Normative references

2.1.1 For undated references to standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this standard was approved. For dated references to standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the standard was approved.

ANCE (Mexican National Standards)

NMX-J-024-ANCE
Iluminación – Portalámparas roscados tipo Edison – Especificaciones y métodos de prueba

NMX-J-325-ANCE
Iluminación – Portalámparas para lámparas fluorescentes – Especificaciones y métodos de prueba

NMX-J-565/2-11-ANCE
Prueba de riesgo de incendio – Parte 2-10: Métodos de prueba basados en hilo incandescente/caliente – Método de prueba de inflamabilidad de hilo incandescente para productos finales

NOM-001-SEDE
Instalaciones Eléctricas (utilización)

NOM-058-SCFI
Productos eléctricos – Balastros para lámparas de descarga eléctrica en gas – Especificaciones de seguridad

NMX-J-578-ANCE
Iluminación – Lámparas fluorescentes compactas autobalastradas – Seguridad y métodos de prueba

CSA Group

C22.1-12
Canadian Electrical Code (CEC), Part I, Safety Standard for Electrical Installations

CAN/CSA-C22.2 No. 0-10
General Requirements – Canadian Electrical Code, Part II

C22.2 No. 0.1-M1985 (R2008)
General Requirements for Double-Insulated Equipment

C22.2 No. 0.15-01 (R2006)
Adhesive labels

CAN/CSA-C22.2 No. 0.17-00 (R2009)
Evaluation of Properties of Polymeric Materials

CAN/CSA-C22.2 No. 43-08
Lampholders

C22.2 No. 66.1-06 (R2011)
Low Voltage Transformers – Part 1: General Requirements

CAN/CSA-C22.2 No. 74-96 (R2010)
Equipment for use with electric discharge lamps

CAN/CSA-C22.2 No. 250.0-08
Luminaires

C22.2 No. 250.13-12
Light Emitting Diode (LED) Equipment for Lighting Applications

C22.2 No. 256-05 (R2010)
Direct Plug-In Nightlights

CAN/CSA-C22.2 No. 60065-03 (R2008)
Audio, Video and Similar Electronic Apparatus – Safety Requirements

C22.2 No. 60950-1-07 (R2012)
Information Technology Equipment – Safety – Part 1: General Requirements

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

UL (Underwriters Laboratories Inc.)

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

UL 101
Leakage Current for Appliances

UL 496
Lampholders

UL 746C
Polymeric Materials – Use in Electrical Equipment Evaluations

UL 746F
Polymeric Materials – Flexible Dielectric Film Materials for Use in Printed-Wiring Boards and Flexible Materials Interconnect Constructions

UL 796
Printed-Wiring Boards

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

UL 935
Fluorescent-Lamp Ballasts

UL 969
Marking and Labeling Systems

UL 1029
High-Intensity-Discharge Lamp Ballasts

UL 1310
Standard for Class 2 Power Units

UL 1412
Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances

UL 1446
Systems of Insulating Materials – General

UL 1598
Luminaires

UL 1694
Standard for Tests for Flammability of Small Polymeric Component Materials

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

UL 8750
Standard for Light Emitting Diode (LED) Equipment for Use In Lighting Products

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

ANSI (American National Standards Institute)

ANSI C78.24
Electric Lamps: Two-inch (51-mm) Integral-Reflector Lamps with Front Covers and GU5.3 of GX5.3 Bases

ANSI C78.81
Electric Lamps – Double-Capped Fluorescent Lamps – Dimensional and Electrical Characteristics

ANSI C81.61
Specifications for Bases (Caps) for Electric Lamps

ANSI C81.62
Electric Lampholders

ANSI C81.63
Gauges for Electric Lamp Bases and Lampholders

ANSI/ISA (American National Standards Institute/Instrumentation, Systems, and Automation Society)

ANSI/ISA MC96.1
Temperature Measurement Thermocouples

ASTM (American Society for Testing and Materials)

ASTM D 1000
Standard Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

ASTM E 28
Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus

NFPA (National Fire Protection Association)

NFPA 70
National Electrical Code (NEC)

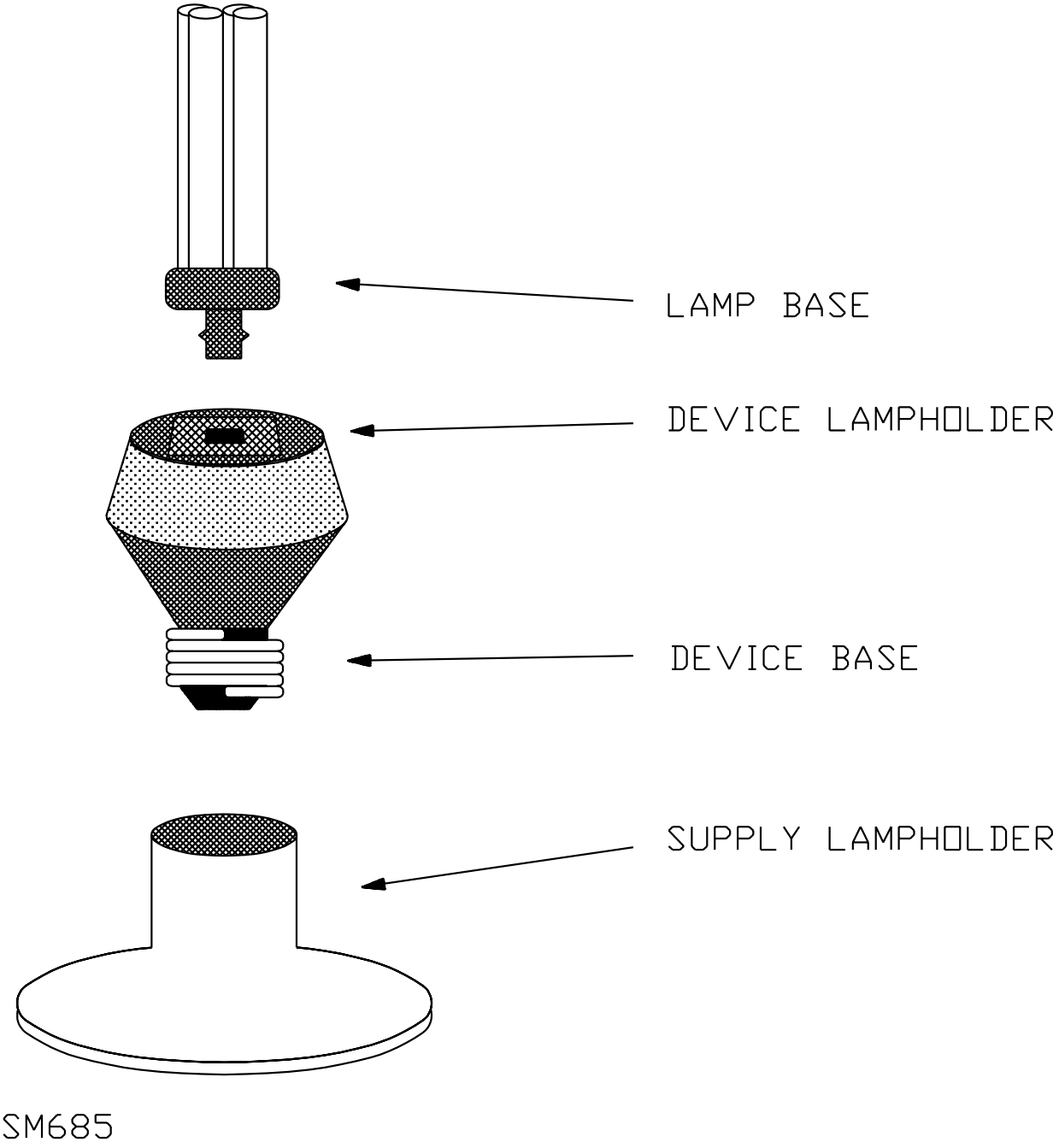
2.2 Informative references

2.2.1 See Annex A for a list of component standards.

3 Definitions

3.1 The following terms and definitions apply in this standard. See Figure 3.1 for illustrations of the definitions in Clauses 3.4, 3.5, and 3.20.

Figure 3.1
Example of terminology for lamp adapters
(See Clause 3.1)



3.2 ACCESSIBLE NON-CURRENT-CARRYING CONDUCTIVE (METAL) PART – a conductive part without basic insulation that, under normal operating conditions, carries no electrical current. A grounded dead conductive part may carry leakage current.

3.3 DEVICE – a self-ballasted lamp or lamp adapter. The specific name is used when it applies to only one of the devices.

3.4 DEVICE BASE – a screw-base or other ANSI base that connects the device to a mating lampholder for outlet boxes or to lampholders provided in luminaires, portable luminaires, or signs.

3.5 DEVICE LAMPHOLDER – a lampholder provided for the replaceable light source.

3.6 DEVICE LAMPHOLDER KEYING – a lampholder design that can accommodate only matching lamp bases.

3.7 DOUBLE INSULATION – an insulation system comprised of both basic insulation and supplementary insulation.

3.8 ELECTRONIC BALLAST – a ballast, generally involving high-frequency switching that is controlled by active components (transistors, thyristors, and the like), and with the lamp ballasting impedance provided by a series capacitive or inductive reactance appropriate for the high switching frequency. “Ballast” also refers to other drivers or supplies that operate lamp technologies other than fluorescent.

3.9 ENCLOSURE – a material provided to enclose parts and components that can involve the risk of fire or electric shock hazard.

3.10 LAMP ADAPTER – a self-ballasted lamp with a replaceable light source.

3.11 LAMP CONNECTOR – a set of contacts attached to flexible conductors that provides a removable means for electrical connection to a lamp but does not provide mechanical support.

3.12 LAMP, SELF-BALLASTED – a device provided with a lamp base and incorporating a non-replaceable light source and any additional elements necessary for starting and stabilizing operation of the light source, which cannot be dismantled without being permanently damaged.

3.13 LIVE PART – a metal or other conductive part that, during intended use, has an electrical potential difference with respect to earth ground or any other conductive part. The grounded (or neutral) supply conductor is considered to be a live part.

3.14 LIVE PART, HAZARDOUS – a conductive part without basic insulation, where a risk of electric shock exists.

3.15 LOCATION, DAMP – an exterior or interior location that is normally or periodically subject to condensation of moisture in, on, or adjacent to electrical equipment, including partially protected locations. The interior of a luminaire or sign intended for wet locations is considered a damp location.

Note 1: Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold storage warehouses.

Note 2: Devices intended for damp locations may also be used in dry locations.

3.16 LOCATION, DRY – a location not normally subject to dampness, but could include a location subject to temporary dampness.

Note: For example, a building under construction.

3.17 LOCATION, WET – a location in which water or other liquid can drip, splash, or flow on or against a device.

Note 1: For example, vehicle washing areas, showers, or unprotected locations exposed to weather.

Note 2: Devices intended for wet locations may also be used in dry and damp locations.

3.18 LUMINAIRE, RECESSED – a luminaire that is designed to be either wholly or partially recessed in a mounting surface.

3.19 POWER CAPACITOR – a capacitor used with a magnetic ballast that is connected:

a) In series with a lamp or lamps and provides the ballast impedance for the lamp current, or

b) For power-factor correction across the input leads of the ballast or across an extension of the primary winding.

3.20 SUPPLY LAMPHOLDER – a lampholder of a luminaire or portable luminaire or sign that can accommodate and supply power to a self-ballasted lamp or lamp adapter.

3.21 TYPE TEST – testing of a representative sample of the device with the objective of determining if the device, as designed and manufactured, can meet the requirements of this standard.

4 General Requirements

4.1 Components

4.1.1 Except as indicated in Clause 4.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the ANCE, CSA, or UL standards as appropriate for the country where the product is to be used.

In Mexico, the requirements of Clause 4.1 do not apply.

4.1.2 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.

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

4.1.4 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.

4.2 Application of requirements

4.2.1 The requirements of the national installation codes and other practices of Canada, Mexico, and the United States have been addressed in the requirements of this standard.

4.2.2 A product intended to be used in Canada, Mexico, and the United States shall comply with the requirements of this standard for those countries.

4.2.3 A product to be used only in Canada, Mexico, or the United States shall comply with the common requirements of this standard and the applicable country-specific requirements, where so noted.

4.3 Units of measurement

4.3.1 The values given in SI (metric) units shall be normative. Any other values are for information only.

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

4.3.3 All values of voltage and current are root mean square (rms) values unless otherwise noted.

4.3.4 Temperatures are given in Celsius only.

4.4 Assembly and packaging

4.4.1 A device shall be completely assembled and wired with each electrical component mounted in place and with each splice and connection completed when shipped from the factory. The lamp may be packaged separately in the case of a lamp adapter.

4.5 Principles

4.5.1 Risk of electric shock

4.5.1.1 Risk of electric shock can occur due to a number of factors, including:

a) Voltage between conductive parts,

b) Current available,

c) Whether the current is pulsed or continuous,

d) Frequency of voltage and current,

e) Pathway through the human body, and

f) Skin resistance.

4.5.1.2 Risk of electric shock is usually defined only in terms of electrical voltage, current, and frequency. Throughout this standard, voltage between parts greater than 30 V_{rms}, 42.4 V_{peak} (and DC) – half of these limits for wet locations – is considered to be a risk of electric shock. When the current available is greater than 0.5 mA_{rms} for perception and greater than 5.0 mA_{rms} for let-go, for direct current and alternating current up to 1 kHz, the current is considered to be a risk of electric shock. A passive network connected across the meter input terminals of a measuring instrument compensates for the pathway body impedance and frequency. The test method and meter network are described in UL 101.

4.5.2 Risk of fire

4.5.2.1 The risk of fire can occur when electrical energy is converted to heat, and the heat is entrapped. It is difficult to define the energy level in terms of electrical parameters alone because the degree of entrapped heat will determine whether or not there would be combustion. In addition, risk of fire can be abated by a suitable enclosure (fire can be confined by the enclosure).

4.5.2.2 There are several possible indicators that are used while conducting a given test. Throughout this standard, the check for fire hazard is either by a specific temperature limit or a change of an indicator. For example, one fire indicator is a layer of cheesecloth, and its change of state occurs when it ignites and causes combustion.

4.5.2.3 Throughout this standard, an energy level of 15 VA is considered to be a sufficient level to support a fire. A circuit having 15 VA available is considered to be a fire-hazardous circuit.

4.5.2.4 Throughout this standard, a suitable enclosure is described in Clauses 5.1 and 5.3.

5 Mechanical Construction

5.1 Enclosures

5.1.1 Enclosures shall have the strength and rigidity to resist the abuses to which they are subjected, without increasing the risk of fire, electric shock, or injury to persons due to a reduction of the required spacing for live parts or the loosening or displacement of live parts.

5.1.2 An enclosure shall be of metal or of a polymeric material that complies with Clause 5.3.

5.1.3 A metal enclosure shall comply with the minimum thickness specified in Table 5.1.

Table 5.1
Thickness of metal enclosures
(See Clause 5.1.3)

Metal	Minimum thickness, mm (in)	
Cast metal	1.2	(0.047)
Uncoated sheet steel	0.66[a]	(0.026)
Nonferrous sheet metal	0.81	(0.032)

[a] Uncoated sheet steel with a minimum of 0.51 mm (0.020 in) is acceptable if the ballast part of the device is filled with potting compound.

5.1.4 An enclosure constructed of iron or steel shall be protected against corrosion by plating, painting, or the equivalent on both inside and outside surfaces.

5.2 Openings

5.2.1 An enclosure shall not have openings wider than 2 mm (0.078 in), unless they do not permit a 2 mm (0.078 in) diameter rod of any length to contact live parts. The uninsulated live parts of a lampholder into which a lamp connects are not required to comply.

5.2.2 The enclosure openings in a lamp adapter shall be evaluated with the lamp removed.

5.2.3 A hole in an enclosure through which wires emerge to connect with a lamp connector shall be:

a) Close-fitting to the emerging lead wires,

b) Free of burrs, sharp edges, and the like, that can abrade the insulation, and

c) Provided with a strain-relief means that complies with the strain relief test for lamp connectors of Clause 8.11.

5.3 Polymeric materials

5.3.1 (CAN) In Canada, a polymeric material shall comply with the requirements in CAN/CSA-C22.2 No. 0.17 and with the requirements of Clauses 5.3.2 to 5.3.4 and Clause 5.3.6 when the material is used to:

a) Enclose electrical parts,

b) Provide direct or indirect support of live parts, or

c) Both.

5.3.1 (MEX) In Mexico, the parts of insulating material that contain live parts and external parts of insulating material that provide protection against electrical shock shall be subjected to the glow-wire test in accordance with NMX-J-565/2-11-ANCE and to the following:

a) The test specimen shall be an end product. If it is necessary to take a part from the lamp in order to perform the test, care shall be taken to assure that the test conditions are not significantly different from that which occurs in normal use conditions;

b) The temperature in the tip of the glow-wire shall be 650 °C.

5.3.1 (USA) In the United States, a polymeric material shall comply with the requirements for portable equipment specified in UL 746C and with the requirements of Clauses 5.3.2 to 5.3.6 when the material is used to:

a) Enclose electrical parts,

b) Provide direct or indirect support of live parts, or

c) Both.

5.3.2 A polymeric material used to enclose electrical parts shall have a Relative Thermal Index (RTI), including electrical and mechanical, with impact properties of at least the temperature measured during the temperature test of Clause 8.5, unless the measured temperature is less than 65 °C.

5.3.3 A polymeric material used as an enclosure shall have a flammability rating of 5-VA, 5-VB, or V-0 in accordance with UL 94 or CAN/CSA-C22.2 No. 0.17.

5.3.4 A polymeric material used as an enclosure of a device marked for wet location use shall comply with the ultraviolet light exposure test specified in UL 746C or CAN/CSA-C22.2 No. 0.17.

5.3.5 With respect to UL 746C, the following tests are not required to be conducted:

a) The abnormal operation and severe conditions test,

b) The input after mold-stress relief distortion test, and

c) the volume resistivity test.

5.3.6 A device shall comply with the mold-stress relief distortion test of Clause 8.9.

5.3.7 A polymeric material used for direct support as electrical insulation shall be able to withstand the hot wire ignition (HWI), the comparative tracking index test (CTI), and the high current arc ignition (HAI) to a level of at least the values in accordance with Table 5.2.

Table 5.2
Ratings of polymeric materials[a]
(See Clause 5.3.7)

Environmental rating	Flammability classification[b]	CTI[c]		HWI[d]		HAI[e]	
		Minimum volts	PLC[f]	Minimum seconds	PLC[f]	Minimum seconds	PLC[f]
Dry location	5-VA, 5-VB, V-0	100	4	–	–	–	–
Damp location	5-VA, 5-VB, V-0	175	3	–	–	–	–
Wet location	5-VA, 5-VB, V-0	250	2	–	–	–	–
Any	5-VA, 5-VB	–	–	15	3	30	2
Any	V-0, VTM-0	–	–	7	4	15	3

[a] Enclosures of phenolic, urea, or other thermoset materials are acceptable as legacy materials. Thermoplastic materials shall comply with this table. First, the flammability classification is determined, and then CTI, HWI, and HAI requirements are determined as a function of the flammability classification.

[b] Flammability classification determined by prior classification or by 12-mm end-product (needle) flame test described in UL 746C or CAN/CSA-C22.2 No. 0.17.

[c] Comparative tracking index - Determined by prior classification or by end-product test described in UL 746C or CAN/CSA-C22.2 No. 0.17.

[d] Hot wire ignition - Determined by prior classification or by end-product test described in UL 746C or CAN/CSA-C22.2 No. 0.17.

[e] High-current arc resistance to ignition - Determined by prior classification or by end-product test described in UL 746C or CAN/CSA-C22.2 No. 0.17.

[f] For materials with other than VTM flammability classifications, the performance level class (PLC) for material shall be evaluated using the specimen thickness employed in the end product. PLCs have been established in order to give a consistent numbering for improved performance (PLC=0 is best; PLC=5 is poorest) and avoid an excessive level of implied precision. Material performances for several tests and recorded as PLC values are based on the mean test results rather than recording the exact numerical results.

5.4 Weight and moment

5.4.1 A device shall have weight and moment limitations as specified in Table 5.3.

Table 5.3
Weight and moment limitations
(See Clause 5.4.1)

Device base	Maximum weight,[a,c] kg (lbs)	Maximum moment,[a,b] N·m (in-lbs)
E12 (Candelabra)	0.50 (1.15)	0.60 (5.54)
E17 (Intermediate)	0.75 (1.63)	0.09 (7.85)
E26 (Medium), GU10, GU24	1.15 (2.5)	1.35[c] (12)
E39 (Mogul)	1.70 (3.75)	2.05 (18)

[a] For weight and moment measurements, lamp adapters shall be provided with lamps.
[b] The moment is the weight of a device multiplied by the distance between the center contact of the device lamp base and the center of gravity of the device.
[c] Includes the weight of any glassware and/or shade provided with the device. See Clause 5.4.3.

5.4.2 A device that is constructed so that the alignment with the existing incandescent luminaire or portable luminaire requires an adjustment greater than ±20 degrees shall be provided with adjustment of the device base with relation to the remainder of the device. Examples include:

a) A rectangular-shaped device in which the device is to be parallel with existing walls when installed in a ceiling surface luminaire, and

b) A device incorporating a ballast compartment or lamp support arms that will in some cases have to be rotated more than 20 degrees to properly clear harps in portable luminaires.

5.4.3 A device intended to be used with a shade, glassware, or diffuser shall be provided with that accessory.

5.4.4 A lamp adapter shall be provided with a positive means to retain the lamp or lamps in place in any possible mounting orientation, such as by clips, retaining springs, or the equivalent. A securing means relying solely on the electrical contacts of the lampholder does not meet this requirement.

5.4.5 When the integrity of the lamp securing means of a lamp adapter cannot be determined, the device lampholder shall comply with the minimum retention force values specified in ANSI C81.62, using the appropriate plug gauge specified in ANSI C81.63 for the intended lamp type.

6 Electrical Construction

6.1 Lamp bases and lampholders

6.1.1 A device lampholder and device base shall comply with the requirements of CSA C22.2 No. 43 and UL 496. The screw base metal shell, including double contact types (3-way), shall comply with the material, thickness, and dimensional construction requirements. The screw base metal shell shall be subjected to the pull, torque, and go/not-go tests. A device screw base intended to lock in place and be

non-removable shall be provided with a ratcheting mechanism, or the equivalent, so that the lampholder in which it is installed is not damaged. A skeleton type of construction shall not be used on a device screw base.

In Mexico, a device lampholder and device base shall comply with the requirements of NMX-J-024-ANCE and NMX-J-325-ANCE.

6.1.2 A screwshell metal of a device base shall be made from:

a) Copper alloy with a minimum of 80 percent copper,

b) Nickel alloy,

c) Stainless steel, or

d) Aluminum or copper alloy electroplated with nickel alloy covering all surfaces (after forming and trimming).

Unplated aluminum is acceptable as a screwbase metal only for devices intended for dry and damp locations.

6.1.3 In Canada and the United States, a device lampholder of a fluorescent lamp adapter shall be tested with the lamp or lamps that the device is intended to accommodate. The lampholder shall be keyed to accommodate a specific lamp or lamps or comply with Clause 6.1.4. The lampholder keying shall comply with ANSI C81.61, C81.62, and C81.63.

In Mexico, a device lampholder of a fluorescent lamp adapter shall be tested with the lamp or lamps that the device is intended to accommodate. The lampholder shall be keyed to accommodate a specific lamp or lamps or comply with Clause 6.1.4. The lampholder keying shall comply with NMX-J-024-ANCE and NMX-J-325-ANCE.

6.1.4 A device which does not comply with Clause 6.1.3 shall comply with the lamp starting and operating measurements of Clause 8.3.

6.2 Current-carrying parts

6.2.1 A wire shall have insulation rated for the voltage, temperature, and conditions of intended use.

6.2.2 Where loosening or breaking of electrical connections involves a risk of fire or electric shock, the connections shall be soldered, welded, or otherwise securely connected. A soldered joint shall be mechanically secure before soldering. A surface mount component not exceeding a maximum dimension of 13 mm (0.5 in) need not comply with this requirement.

6.2.3 A wire is considered to be mechanically secure when one or more of the following is provided:

a) At least one full wrap around a terminal,

b) At least one right angle bend when passed through an eyelet or opening, except on printed-wiring boards where components are properly inserted and soldered or mechanically secured by design, or

c) It is twisted with other conductors.

6.2.4 Iron or steel, plain or plated, shall not be used for current-carrying parts unless it is a wire integral to the lamp light source or parts used for the containment of electromagnetic or electrostatic fields.

6.2.5 An uninsulated live part shall be permanently mounted and secured in accordance with Clause 6.2.3 to reduce the likelihood of turning or shifting position if such motion can result in a reduction of spacings below minimum acceptable values.

6.2.6 An accessible wire between a lamp connector for a circular lamp and the device enclosure shall:

a) Be a continuous length of stranded wire with no splices,

b) Incorporate a conductor of 0.52 mm^2 (20 AWG) or larger,

c) Have insulation 0.8 mm (1/32 in) thick or greater, and

d) Comply with the strain relief test of Clause 8.11.

6.3 Printed circuit boards

6.3.1 In Canada, printed circuit wiring boards shall comply with Annex E.

In the United States, printed circuit wiring is considered part of the ballast, and shall comply with UL 935 (see Clause 6.4.1).

In Mexico, Clause 6.3 does not apply because in Mexico the tests are carried out on the end product, not to components.

6.4 Ballasts and LED drivers

6.4.1 In Canada, a conventional magnetic ballast for discharge lamps shall comply with the requirements of CSA C22.2 No. 74 and have a thermal protector. Electronic ballasts for discharge lamps may be inherently protected.

In Mexico, a ballast shall comply with the requirements of NOM-058-SCFI and have a thermal protector.

In the United States, a ballast for fluorescent lamps shall comply with the requirements of UL 935 and have Class P thermal protection. A ballast for high-intensity discharge lamps shall comply with the requirements of UL 1029 and UL 935.

6.4.2 A ballast not previously investigated as described in Clause 6.4.1 shall be evaluated in the device. The construction requirements of UL 935 or CSA C22.2 No. 74 or NOM-058-SCFI shall apply. See the appropriate standard for details on coil insulation materials, thermal and overcurrent protective components, printed wiring boards, and spacing of electrical parts on the printed wiring board.

6.4.3 A ballast for fluorescent lamps shall be subjected to the following tests:

a) For the normal temperature test of Clause 8.5, the device shall be installed in the test fixture described therein. The maximum surface ballast temperature shall be measured by a thermocouple on the outer surface of the device, and

b) The abnormal-temperature test and fault-condition test (Class P) thermally protected ballasts described in UL 935 or the fault conditions test described in CSA C22.2 No. 74 or the Condición de falla described in NOM-058-SCFI.

6.4.4 Regarding the fault condition testing specified in Clause 6.4.3 (b), the following fault conditions shall be introduced, one at a time – not necessarily in the order indicated:

a) For a transformer winding or power inductor, two outer layers of a layer wound coil or 20 percent of the turns of a random wound coil are short-circuited, and

b) Any electrolytic capacitor or semiconductor junctions shall be short-circuited or open-circuited.

6.4.5 A fusing resistor used for thermal protection shall comply with UL 1412 or the requirements of CAN/CSA-C22.2 No. 60065-03 (R2008) or the requirements of NMX-J-578-ANCE. Testing shall include the Limited Short Circuit test while installed in the application, unless the test was previously conducted in accordance with UL 1412 or CSA C22.2 No. 256. If a clearance to combustible materials was used during the Overload Test, as permitted in UL 1412, the clearance shall be maintained or, the Overload Test shall be conducted while the resistor is installed in the application.

6.4.6 A printed wiring board trace intended to open as a result of an abnormal condition is not permitted.

6.4.7 In Canada, a magnetic coil shall have an insulation system complying with the General Requirements – Canadian Electrical Code, Part II, CAN/CSA-C22.2 No. 0.

In the United States, a magnetic coil operating above Class 105 temperature limits shall have an insulation system complying with UL 1446. A ballast completely enclosed in a polymeric enclosure complying with Clause 5.3, and with no accessible current-carrying (such as low voltage circuitry) or non-current-carrying (such as a ferrite core) metal parts that are capable of being energized is not required to comply with UL 1446. However, the respective electrical Relative Thermal Index (RTI) of the individual materials shall be greater than the operating temperature determined during the temperature test in Clause 8.5.

In Mexico, Clause 6.4.7 does not apply.

6.4.8 Drivers for light-emitting diodes (LEDs) vary in complexity from simple to complex circuits. For the circuits, the requirements for construction and testing would be similar to what is required for fluorescent lamp ballasts. The construction features of the overall device affect the evaluation of the LED driver. When the LEDs are accessible to the user, it is necessary to determine that the LEDs are not hazardous live parts and that basic insulation exists in the driver circuitry between the accessible live parts and the source of supply. When the LEDs are inaccessible and enclosed in a suitable electrical enclosure, it will in some cases not be necessary to determine that a basic insulation exists in the driver circuitry between the internal live parts of the LEDs and the source of supply.

6.5 Power capacitors

6.5.1 In Canada, a power capacitor shall comply with the applicable requirements specified in CSA C22.2 No. 74.

In the United States, a power capacitor shall comply with the applicable requirements specified in UL 935.

6.6 Spacing of electrical parts

6.6.1 For other than on a printed wiring board, the spacing of electrical parts through air (clearance) and over the surface of insulating material (creepage distance) shall be at least as described in Clauses 6.6.2 and 6.6.3 for the following:

a) Uninsulated live parts of opposite polarity, and

b) An uninsulated live part and a non-current-carrying metal part exposed to contact by persons.

6.6.2 Alternate spacing requirements may be applied as specified in Clauses 6.6.5 to 6.6.7.

6.6.3 A spacing described in Clause 6.6.1 shall not be less than the values specified in Table 6.1.

Table 6.1
Minimum spacing, dry, damp, and wet locations
(See Clause 6.6.3)

Location Type	Potential, V[a]	Minimum spacing, mm (in)	
		Through air or over surface	
Dry or damp	300 or less (425)	1.2	(0.046)
Dry or damp	301 – 600 (426 – 846)	3.2	(0.125)
Wet	Less than 600 (848)	4.8	(0.187)

[a] The figures in parentheses are peak voltages. When evaluating the voltage of a circuit that produces other than sinusoidal waveform, both rms and peak values are evaluated and the requirement for the larger spacing shall be applied.

6.6.4 For a printed wiring board, the spacing of electrical parts for the ballast shall comply with the requirements of UL 935 or CSA C22.2 No. 74 as applicable. However,

a) When the power available between two insulated parts is less than 50 W when determined in accordance with the fault condition test of UL 935 (maximum: 1 minute), the spacing is not required to comply with this requirement.

b) When the minimum spacing is determined by the dielectric voltage-withstand test to a dielectric potential of 2 V + 1000 V DC for 1 min, where V equals the maximum peak potential, in volts, between the foil traces, the spacing is not required to comply with this requirement.

6.6.5 In the United States, as an alternative to the spacing requirements specified in Clauses 6.6.2 to 6.6.4, the clearance and the creepage distance between conductive parts that are rigidly held in place and reliably spaced in production may be evaluated for compliance with UL 840. The spacing requirements in UL 840 shall not be applied to a spacing to an exposed non-current-carrying metal enclosure. Creepage distances shall not be less than clearances.

6.6.6 In the United States, when applying the requirements specified in UL 840 to determine clearances, the device may be considered as operating on a supply circuit having an over-voltage of Category II.

6.6.7 In the United States, when applying the requirements specified in UL 840 to determine environmental pollution, the device may be evaluated with different environmental pollution degrees. The following conditions apply:

a) A device marked for wet use shall be exposed to environmental pollution degree 3.

b) A device intended for dry or damp locations shall be exposed to environmental pollution degree 2.

c) The portion of a printed wiring board covered with a potting compound or a conformal coating that complies with the requirements in conformal-coating tests described in UL 746C shall be exposed to environmental pollution degree 1.

6.6.8 In Canada, printed circuit boards covered with potting compound or a conformal coating shall comply with the requirements of Annex E.

6.7 Accessibility of live parts

6.7.1 Accessibility of hazardous live parts shall be determined when the articulated probe of Clause 9.6 is inserted through any opening without contacting any hazardous live parts.

6.7.2 The articulated probe of Clause 9.6 shall not contact any bare live parts of the lampholder contacts of a fluorescent adapter with the lamp removed.

6.7.3 A non-current-carrying metal part, such as the head of a screw or rivet, is not considered to be exposed to contact if it is recessed to clear the surface by at least 5 mm (0.197 in) in a hole not more than 7 mm (0.275 in) in diameter.

6.8 Light source – fluorescent lamps

6.8.1 Fluorescent discharge lamps shall be tested to simulate end-of-lamp-life conditions as follows:

a) For a lamp operated with a conventional magnetic ballast, the lamp shall be subjected to a shorted starter or deactivated lamp condition as described in the abnormal temperature test in UL 935 or in CSA C22.2 No. 74.

b) For either self-ballasted lamps or lamp adapters that employ an electronic ballast, the lamp fault conditions test as described in Clause 8.16 shall be conducted.

c) For lamp adapters that employ an electronic ballast, one of the end-of-lamp-life tests as described in Clause 8.17 shall be conducted. Note that there are three tests described although it is only necessary to comply with one of the tests.

d) For self-ballasted lamps that employ an electronic ballast, the one filament, emissive-mix-free test as described in Clause 8.18 shall be conducted.

6.9 Light source – light emitting diodes (LED)

6.9.1 Light-emitting diodes (LEDs) emitting coherent light shall not be used.

6.9.2 LEDs used in the subject screw-base lamps shall not be user replaceable.

6.9.3 LEDs used in the subject screw-base lamps shall not be provided with shunt devices that would handle the current in the event the LEDs had open-circuited.

6.10 Light source – non-discharge lamps

6.10.1 Adapters with a lamp containment barrier and employing replaceable tungsten halogen lamps shall be marked with a lamp caution in accordance with Table 10.1, Items 8 and 16.

In Canada, the caution marking of Table 10.1, Item 8, is not required.

6.10.2 Adapters employing replaceable tungsten halogen lamps where the lamp has an integral containment barrier shall be marked with a maximum lamp caution in accordance with Table 10.1, Items 8 and 15.

6.10.3 Adapters complying with Clause 6.10.1 or Clause 6.10.2 may be marked indicating the lamp is suitable for use in an open type luminaire in accordance with Table 10.1, Item 17. Alternatively, the adapter may be marked with the symbol shown in Annex F, Figure F.1, along with instructions on the packaging explaining the symbol and that this type of lamp does not require additional shielding.

7 Environmental Locations

7.1 Dry locations

7.1.1 A device intended for use only in dry locations shall be marked in accordance with Table 10.1, Item 9.

7.1.2 The device or packaging of a device intended for use in dry locations shall not be marked in any manner that could imply or depict that it is suitable for a damp or wet use location.

7.2 Damp locations

7.2.1 A device intended for use in damp locations and marked in accordance with Table 10.1, Item 10, shall:

a) Comply with the spacing requirements for damp locations or pollution degree 2 of Clause 6.6,

b) Have base contacts made of materials suitable for use in damp locations that comply with the requirements in Clause 6.1.2, and

c) Comply with the humidity test of Clause 8.13 if the device has accessible non-current-carrying metal parts.

7.3 Wet locations

7.3.1 A device intended for use in wet locations and marked in accordance with Table 10.1, Item 11 or 12, shall:

a) Comply with the spacing requirements for wet locations or pollution degree 3 of Clause 6.6,

b) Have base contacts made of materials suitable for use in wet locations that comply with the requirements in Clause 6.1.2,

c) Have polymeric enclosures comply with the UV rating of Clause 5.3,

d) Comply with the humidity test of Clause 8.13 if the device has accessible non-current-carrying metal parts,

e) Comply with the water spray test of Clause 8.14, and

f) Comply with the cold impact test of Clause 8.15.

8 Tests

8.1 General

8.1.1 Compliance with this standard is checked by conducting the tests specified and appropriate for the product. Tests according to this standard are tests that are done on samples that represent others of similar construction. The requirements and tolerances permitted by this standard are related to testing of representative samples submitted by the manufacturer for that purpose. Compliance of the sample does not ensure compliance of the whole production of a manufacturer with this safety standard. Conformity of production is the responsibility of the manufacturer and can additionally include routine factory audits, tests, and quality assurance.

8.1.2 Tests described in this section use instrumentation, apparatus, and environmental conditions that are described in Clause 9.

8.1.3 Manufacturing and production tests shall be carried out in accordance with Annex D.

8.1.4 The tests shall be conducted on samples as specified in Table 8.1. The test plan summary provides the number and any special preparation of the sample or samples.

Table 8.1
Test plan summary
(See Clause 8.1.4)

Test description	Reference	Number and description of samples
Electrical Tests		
Input measurements	8.2	1 sample of device along with lamps it is intended to operate with.
Lamp starting and operating measurements	8.3	1 sample of device along with lamps it is intended to operate with; can be same as used in the input test.
Enclosure leakage-current test	8.4	1 sample of device along with lamps it is intended to operate with; can be same as used in the input test.
Normal temperature test	8.5	1 sample of device along with lamp that drew the greatest wattage in input test. If the device were normally potted, it would be necessary to prepare a sample with thermocouples attached prior to potting. If acceptable to all parties concerned, the sample for test can be unpotted.
Dielectric voltage-withstand test	8.6	1 sample of the device – can be the same as used for input measurements, but not the sample for temperature test as the thermocouples can interfere with the test.
Harmonic distortion test	8.7	1 sample of the device – can be the same as used for input measurements.
Mechanical Tests		
Lamp base test in UL 496 or CAN/CSA-C22.2 No. 43	6.1.1	6 samples, assembled (Pull test); 6 samples, assembled (Torque); 6 samples, unmounted (Go / Not-go gauging tests)
Drop impact test	8.8	If the enclosure is plastic, one sample of each enclosure type can be subjected to 3 drops, or if suitable to all concerned, three samples each of which can be subjected to one drop.
Enclosure mold-stress relief conditioning	8.9	1 sample of each enclosure type; may be same as used in drop test.
Deflection test	8.10	1 sample of each enclosure type; may be same as used in drop test.
Strain relief test	8.11	If device has lead wires and is not potted, 1 sample; can be the same as used above.
Special Tests		
Tests with dimmer circuits	8.12	1 sample; may be used in previous tests.
Humidity conditioning test	8.13	For damp location rating, 1 sample; may be used in previous tests.
Water spray test	8.14	For wet location rating and device is not potted, 1 sample of each enclosure type; can be the same as used above.
Cold impact test	8.15	For wet location rating, three samples of each enclosure type.
Lamp fault conditions tests	8.16	For devices with electronic ballast, multiple test conditions are defined in this section. Samples should be easily disassembled to access lamp filament connections; minimum of 6 samples recommended.
End of lamp life tests for adapters	8.17	For lamp adapters with electronic ballasts, three tests are described in this section. If previously determined which test of the three will be conducted, only one sample is needed. If the test has not been previously determined, one sample would be needed for each of the three tests.
End of lamp life tests for self-ballasted fluorescent lamps	8.18	For self-ballasted lamps with electronic ballasts, specially prepared samples are needed. Three samples shall have no emission mix on one lamp filament, and three samples shall have no emission mix on the other filament.
Component abnormal conditions	6.4.3 (b)	1 sample for each component fault, or less if it can be determined that fewer samples would be needed if the fault condition would cause the sample to be unusable. Potted samples would need to have additional wires to attach to internal connections so that the short condition can easily be created. Devices that are normally potted can be tested without potting if agreeable to all parties concerned.
Miscellaneous		

Table 8.1 Continued on Next Page

Table 8.1 Continued

Test description	Reference	Number and description of samples
Sample for report description		1 sample that is easily disassembled or unpotted.
Note: This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.		

8.1.5 All tests shall be conducted with the device connected to a supply circuit of rated frequency. The supply voltage shall be the maximum rated voltage, but not less than 120 V.

8.1.6 A device rated 50 – 60 Hz need only be tested at 60 Hz unless testing at 50 Hz represents a more severe condition. A device without a frequency rating shall be tested at 60 Hz.

8.1.7 Prior to taking the measurements required by Clauses 8.2 to 8.4, it will in some cases be necessary to take preliminary measurements using an oscilloscope to determine the nature of the available currents. An AC/DC meter shall be used for measuring DC.

8.1.8 A device with discharge lamp or lamps shall be aged for 100 hours while connected to a supply of nominal rated voltage, and then all lamp types being tested shall be connected to a regulated source of supply at rated voltage and operated for 30 minutes prior to conducting the input measurements test of Clause 8.2.

8.1.9 Where more than one fluorescent lamp has a common base, for example a G-23 base for 5-, 7-, and 9-W twin tube lamps, and a G-24q-1 base for 10- and 13-W quad lamps, tests on lamp adapters shall be conducted with the lamps that will result in the most severe condition. See Clause 6.1.3.

8.2 Input measurements

8.2.1 With the ballast energized at the input voltage and frequency in accordance with Clauses 8.1.5, 8.1.6, and 8.1.8, the input current shall not be more than 110 percent of the marked rating, and, if additionally marked for wattage, the input wattage shall not be more than 110 percent of the marked rating plus 0.5 W with the device in the base up position controlling:

a) A lamp or lamps which the device lampholder can accommodate, and

b) No lamp in the case of a lamp adapter.

8.2.2 For a device with a marked power factor rating, the power factor (PF) shall be calculated using the following formula:

$$P.F. = \frac{input\ \ wattage}{(input\ \ voltage)\ x\ (input\ \ current)}$$

in which the input wattage, voltage, and current are measured in accordance with Clause 8.2.1. The calculated power factor shall be equal to or greater than the marked rating. See Table 10.1, Item 7, for additional marking requirements.

8.3 Lamp starting and operating measurements

8.3.1 Lamp adapters with the lamp adapter energized at the input voltage and frequency as specified in Clauses 8.1.5 and 8.1.6, and with device lampholders not keyed in accordance with ANSI C81.61, C81.62, and C81.63, shall be in accordance with the lamp manufacturer's specifications. The measurements shall be carried out for each lamp type that can be accommodated by the device lampholder. The measured lamp voltage and current shall not differ by more than 10 percent from the rated value.

8.4 Leakage-current test

8.4.1 A device with an exposed non-current-carrying metal part shall comply with the leakage current requirements in UL 935 or CSA C22.2 No. 74 or NOM-058-SCFI. The measurement shall be made from any accessible non-current-carrying metal part of the enclosure of the device.

8.5 Temperature test

8.5.1 A device shall be tested as described in Clauses 8.5.2 to 8.5.13.

8.5.2 The maximum temperatures shall not exceed those specified in Table 8.2 when corrected to a room ambient temperature of 25 ±5 °C. Ambient temperature variations above or below 25 °C shall be respectively subtracted from or added to temperatures recorded at points on the device.

Table 8.2
Maximum acceptable temperature limits
(See Clause 8.5.2)

Item	Components	Maximum °C, thermocouple method	Maximum °C, rise of resistance method
1.	Capacitor	a,b	
2.	Fuses	90	
3.	Coil insulation systems	b, e	
	Class 105 insulation systems	90/95[f]	95
	Class 130 insulation systems	110/120[f]	120
	Class 155 insulation systems	135/140[f]	140
	Class 180 insulation systems	150/165[f]	165
4.	Potting compound	c	
5.	Printed-wiring boards	a, b	
6.	Internal wiring	a	
7.	Soldered joint of a resistance ballast	150	
8.	Lamp base without an integral starter	150	

Table 8.2 Continued on Next Page

Table 8.2 Continued

Item	Components	Maximum °C, thermocouple method	Maximum °C, rise of resistance method
	Electrical Insulation		
9.	Vulcanized fiber employed as electrical insulation for other than coil systems	90[d]	
	Surfaces		
10.	Any outer polymeric surface	a, b	

[a] The manufacturer's rated temperature of the material or component shall be used.

[b] For a self-ballasted lamp, the temperature limit of a polymeric material may be increased above the established RTI value for 70,000 hours to correspond with the maximum expected lamp life. For fluorescent lamps, 5,000 to 10,000 hours life is typical. See UL 746C clauses on RTI for discussion of this technique.

[c] Unless the material is thermosetting, the maximum potting compound temperature, when corrected to a 25 °C ambient temperature, shall be at least 15 °C less than the softening point of the compound as determined by the test methods of ASTM E 28.

[d] For vulcanized fiber that has been investigated for use at a higher temperature, that higher temperature would apply.

[e] Regarding insulation systems and Clause 6.4.7, the maximum acceptable coil temperature shall be the lowest temperature rating of any insulating material or component used in the ballast.

[f] For coil assemblies weighing 250 g (0.5 lbs) or less.

8.5.3 A device shall be tested as follows:

a) If the device is capable of being installed in the smaller test fixture shown in Figure 9.1, it shall have temperatures measured with the device mounted in the test fixture that simulates operation in a typical recessed luminaire. The device shall be tested base up.

b) A device that will not fit in the smaller test fixture shown in Figure 9.1 but that can be installed in the larger test fixture shall be tested in such a test fixture. The device shall be tested base up.

c) A device exceeding the diameter of the test fixture shall have temperatures measured with the device mounted on a draft-free bench. The device shall be tested with both a base-up and base-down orientation, unless it is obvious that one orientation would result in less severe heating.

d) A device with a candelabra base shall be tested in the same test described in (a), except that it shall be permissible either to use a medium to candelabra adapter or to change the lampholder to a candelabra type.

e) A device with an input rating greater than 50 W and

1) Marked for installation in a fully enclosed luminaire with minimum lamp compartment dimensions in accordance with Table 10.1, Items 23 and 24, shall be normal temperature tested with the device mounted base up in the test fixture described in Clause 9.5.2,

2) Marked for installation only in an open surface-mounted luminaire in accordance with Table 10.1, Item 25, shall be normal temperature tested with the device in a lampholder mounted to the outlet box on the insulated test ceiling described in Clause 9.5.3 and depicted in Figure 9.2, or

3) Marked for installation in a specific luminaire only in accordance with Table 10.1, Item 26, shall be normal temperature tested in the specified luminaire in accordance with UL 1598 and CAN/CSA-C22.2 No. 250.0 for the luminaire type.

8.5.4 The normal temperature test shall be conducted with the device energized in accordance with Clause 8.1.5.

8.5.5 A device that is not marked in accordance with Table 10.1, Item 13, shall comply with the dimmer tests of Clause 8.12.

8.5.6 A device that is not designed for use in a totally enclosed luminaire, and that is marked in accordance with Table 10.1, Item 14, shall be subjected to the normal temperature test with the device mounted base-up in the test fixture as shown in Figure 9.1 and with the bottom open. The open bottom of the test fixture shall remain open for the temperature test, or the device shall be tested with a 3 mm (0.125 in) thick lens applied to the test fixture opening.

8.5.7 A lamp adapter that can accommodate various lamp types and wattages shall be tested with the lamp that will result in the most severe temperatures. More than one test will in some cases be required to determine this condition.

8.5.8 The test shall be continued until constant temperatures are obtained. A temperature is considered to be constant if:

a) The test has been running for at least 3 hours, and

b) Three successive readings, taken at 15 minute intervals, are within 1 °C of one another and are still not rising.

8.5.9 Thermocouples shall comply with Clause 9.3.

8.5.10 A thermocouple junction and the adjacent thermocouple lead wire shall be securely held in thermal contact with the surface of the material of which the temperature is being measured. In most cases, adequate thermal contact will result from securely cementing the thermocouple in place. If a metal surface is involved, brazing or soldering the thermocouple to the metal might be necessary.

8.5.11 The temperature of a winding shall be measured by a thermocouple or by the rise of resistance method in accordance with Clause 8.5.12.

8.5.12 The temperature of a winding shall be calculated by the following formula:

$$T_H = \frac{R_H}{R_C} (T_C + k) - k + (T_{AT} - T_A)$$

in which:

T_H is the temperature of the coil in degrees C at the end of the test, normalized for a target ambient temperature, normally 25 °C,

R_H is the resistance of the coil, in ohms, at the end of the test,

R_C is the resistance of the coil, in ohms, at the beginning of the test,

T_C is the temperature of the coil in degrees C at the beginning of the test when R_C is measured,

k is 234.5 for copper or 225.0 for electrical conductor grade (EC) aluminum. Values of the constant for other grades must be determined,

T_{AT} is the target ambient temperature, normally 25 °C, unless the device is being tested for a higher ambient rating such as 40, 55, 65, etc. degrees C, and

T_A is the temperature of the ambient air in degrees C at the end of the test when R_H is measured.

8.5.13 As it is generally necessary to de-energize the winding before measuring R, the value of R at the end of the test may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values versus time may be plotted and extrapolated to give the value of R at the end of the test.

8.6 Dielectric voltage-withstand test

8.6.1 A device with accessible non-current-carrying metal parts that could be energized from within shall withstand for 1 minute, without breakdown, the application of a test potential of twice the rated voltage + 1000 V between all live parts and all accessible non-current-carrying metal parts.

8.6.2 A device with accessible nonmetallic parts and openings in the enclosure shall withstand for 1 minute, without breakdown, the application of a test potential of 2500 V between live parts and metal foil in contact with accessible nonmetallic parts. The test shall be performed while the device is hot from normal operation.

8.6.3 The dielectric voltage-withstand test shall be conducted using test equipment having a 500 VA or larger transformer, the output voltage of which can be varied. The applied potential shall be increased from zero until the required test value is reached, and shall be held at that value for 1 minute. The increase in the applied potential shall be at a substantially uniform rate and as rapidly as consistent with its value being correctly indicated by a voltmeter.

8.6.4 The sensitivity of the test equipment shall be such that when a 120,000 ohms minimum calibrating resistor is connected across the output, the equipment indicates acceptable performance for any output voltage less than the specified test voltage, and indicates unacceptable performance for any output voltage equal to or greater than the specified test voltage.

8.7 Harmonic distortion test

8.7.1 A device rated for a harmonic factor (HF) or total harmonic distortion (THD) of the supply current shall be tested as described in Clause 8.7.2 and 8.7.3. With the device base up and energized at the input voltage and frequency in accordance with Clauses 8.1.5 and 8.1.6, HF or THD shall not be more than the manufacturer's specified rating made for the device by 10 percent when controlling a lamp or lamps that the device lampholder is intended to accommodate.

8.7.2 The supply for the test shall be generated by an electronic power supply having a voltage distortion of less 0.5 percent. Since the source (supply) voltage will affect the magnitude of the harmonics, for measuring purposes, the supply impedance shall be 0.08 ohm. For some electronic supplies it will be necessary to add resistance to obtain the specified supply impedance.

8.7.3 The magnitude of the various harmonics of the supply frequency shall be recorded to the thirty-third (33) harmonic. The harmonic factor is the ratio of the harmonic content to the rms value of the fundamental. The harmonic factor (HF) shall be calculated as follows:

$$HF = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \ldots}}{I_1}$$

The total harmonic distortion (THD) shall be calculated as follows:

$$THD = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \ldots}}{\sqrt{I_1^2 + I_2^2 + I_3^2 + I_4^2 + \ldots}}$$

in which:

I_1 *= 100 percent at the fundamental frequency,*

I_2 *= magnitude, in percent of the fundamental, of the second harmonic, and*

I_3 *= magnitude, in percent of the fundamental, of the third harmonic.*

8.8 Drop impact test

8.8.1 A device with a polymeric enclosure shall be subjected to the tests described in Clauses 8.8.2 and 8.8.3. There shall be no damage to the enclosure making uninsulated live parts or internal wiring accessible to contact or defeating the mechanical protection of internal parts of the equipment afforded by the enclosure. For adapters, the test is conducted since it is assumed the user would replace the lamp. For self-ballasted lamps the test is done because the lamp could be damaged, but it would not be obvious, for example if the lamp is enclosed.

8.8.2 A device shall be subjected to the impact test as follows:

a) A device shall be dropped 0.91 m (3 ft) striking a hardwood surface in the position most likely to produce adverse results. The hardwood surface shall consist of a layer of nominal 25 mm (1 in) thick tongue-and-groove oak flooring mounted on two layers of nominal 19 mm (3/4 in) thick plywood. The assembly shall rest on a concrete floor or an equivalent non-resilient floor during the test.

b) A device shall be dropped three times so that, in each drop, the sample strikes the surface in a position different from those in the other two drops.

8.8.3 A device having accessible non-current-carrying metal parts that could be energized from within shall subsequently be subjected to the dielectric voltage-withstand test of Clause 8.6. There shall be no breakdown as a result of the dielectric voltage-withstand test. There shall be no damage to the enclosure making uninsulated live parts or internal wiring accessible to contact, which is determined using the articulated probe described in Figure 9.3, or defeating the mechanical protection of internal parts of the equipment afforded by the enclosure.

8.8.4 Accessibility criteria are not applied to broken discharge tubes.

8.9 Mold-stress relief conditioning

8.9.1 A completely assembled device having a polymeric enclosure shall be placed in a circulating air oven and maintained at a temperature 10 °C higher than maximum temperature taken during the normal temperature test of Clause 8.5 when tested in a recessed luminaire, or not less than 70 °C for a period of 7 hours.

8.9.2 For a family or grouping of enclosures, such as different sizes for a range of lamp wattages, representative samples of the largest and the smallest enclosures shall be tested. For additional polymeric materials, representative samples of the largest and the smallest enclosures made of each generic type of material (ABS, PBT, PC, PBT/PVC blends, etc) shall be tested. Enclosures made of additional polymeric materials of the same generic type need not be tested (see Appendix A of UL 746C for a discussion of alternate material considerations).

8.9.3 After conditioning, there shall be no softening of the material as determined by handling immediately after the conditioning, nor shall there be shrinkage, warpage, or other distortion as judged after cooling to room temperature, that results in any of the following:

a) Reduction of clearance (through air spacing) between uninsulated live parts of opposite polarity, or, uninsulated live parts and accessible non-current-carrying metal.

b) Making uninsulated live parts or internal wiring accessible to contact, using the probe in Figure 9.3.

8.10 Deflection test

8.10.1 The enclosure of a device shall be capable of withstanding a force of 89 N (20.0 lbf) applied using a 12 mm (0.472 in) diameter rod with a hemispherical end.

8.10.2 This test is applicable only for devices having enclosures consisting of two molded pieces that snap together.

8.10.3 The force shall be gradually increased from zero until the specified value is reached and then maintained for a period of one minute. The force, when applied along a joint of snap-together parts or to any part of the enclosure, shall not result in a shock hazard or damage that can create a fire hazard.

8.11 Strain relief test for lamp connectors

8.11.1 The lamp lead wires that exit the enclosure of a circular fluorescent device shall be subjected to a perpendicular force of 22 N (5 lbs) applied to each lead wire for 1 min.

8.11.2 The lamp leads exiting from the enclosure shall have no movement of any lead greater than 1.6 mm (1/16 in) after the force of Clause 8.11.1 is applied.

8.12 Tests of dimmer circuits

8.12.1 General

8.12.1.1 A device that is not marked in accordance with Table 10.1, Item 13, shall be subjected to the normal operation test specified in Clause 8.12.2.

8.12.1.2 A device that is marked in accordance with Table 10.1, Item 13, shall be subjected to the abnormal temperature test of Clause 8.12.3.

8.12.2 Normal operation test

8.12.2.1 A device intended for use on a dimmer circuit shall comply with the temperature test of Clause 8.5 when operated with power supply sources of Clauses 8.12.4 and 8.12.5.

8.12.3 Abnormal test

8.12.3.1 A device not intended for use on a dimmer circuit shall be energized with the sources of supply specified in Clauses 8.12.4 and 8.12.5, in a room ambient of 25 °C in the base down position. During the test, the device excluding the light source shall be draped with cheesecloth that complies with Clause 9.8. The cheesecloth shall be loosely draped over the device in order to indicate as a flame indicator (presence of ash or burnt holes) but shall not to be used as a blanket to trap heat.

8.12.3.2 When operated as specified in Clause 8.12.3.1 for 7½ hours, there shall be:

a) No flaming, glowing, or charring of the cheesecloth, or

b) No damage to the enclosure which would allow the articulated probe of Clause 9.6 to touch live parts

and the device shall be capable of complying with the dielectric voltage-withstand test of Clause 8.6.

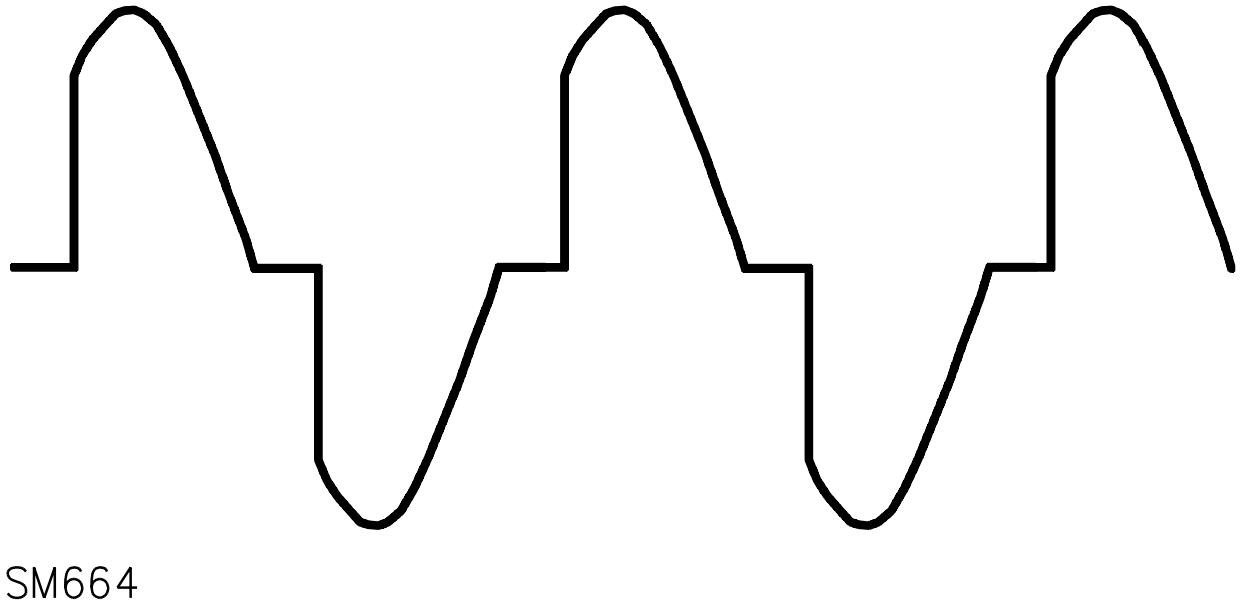
8.12.4 Half-wave rectified supply

8.12.4.1 A source of supply as specified in Clauses 8.1.5 and 8.1.6 shall be operated with a single, appropriately rated semiconductor diode in series with the ungrounded conductor of the supply.

8.12.5 Adjustable dimmer supply

8.12.5.1 A source of supply as specified in Clause 8.1.5 shall be operated with an adjustable dimmer electrically wired in series. The dimmer shall be an adjustable phase-cut type that does not contain any components in its output circuitry for waveform smoothing and should produce an output waveform with a variable conduction angle similar to that depicted in Figure 8.1. The dimmer shall be adjusted to cause the maximum heating of the device.

Figure 8.1
Phase-cut type dimmer output waveform
(See Clause 8.12.5.1)



8.13 Humidity conditioning

8.13.1 A device intended for use in damp or wet locations (see Clauses 7.2 and 7.3) shall be exposed for 48 hours to moist air having a relative humidity of 93 ±2 % at a temperature of 25 ±2 °C. Following the 48-hour period and while still exposed to moist air, the device shall comply with the requirements for dielectric voltage-withstand between current-carrying parts and accessible non-current-carrying metal parts in accordance with Clause 8.6 and operate normally. Alternate chamber conditions may be 88 ±2 % at a temperature of 32 ±2 °C or 93 ±2 % at a temperature of 28 ±2 °C.

8.14 Water spray test

8.14.1 A device intended for use in wet locations (see Clause 7.3) shall be subjected to the test described in Clause 8.14.2. Water shall not enter the ballast or device lampholder compartments. A device that is marked to indicate a specific orientation or restricted positioning (refer to Table 10.1, Item 12, for marking) shall be positioned as marked. A device without a marking for a specific orientation or restricted positioning shall be positioned in the way that results in the most severe test results. A device constructed so that it is sealed to exclude water can be marked per Table 10.1, Item 11, and need not be subjected to this test.

8.14.2 A device shall be tested by applying a water spray as described in Clause 9.7 for 1 hour.

8.15 Cold impact test

8.15.1 A device with a polymeric enclosure and marked for use in wet locations shall comply with the cold impact test (-35 °C) as described in Clause 8.15.2.

8.15.2 Three samples shall be cooled to a temperature of -35 ±2 °C and maintained at this temperature for 3 hours. While the unit is cold, the specimens shall be subject to the drop test described in drop test in Clause 8.8.

8.16 Lamp fault conditions test

8.16.1 A self-ballasted lamp or adapter that employs an electronic ballast shall accept the following fault conditions specified, introduced one at a time, without increasing the risk of fire or shock:

a) A lamp with one cathode open-circuited,

b) A broken lamp, i.e., a lamp with both cathodes intact, but that will not start, and

c) A lamp that operates with one cathode open-circuited, i.e., rectifying effect.

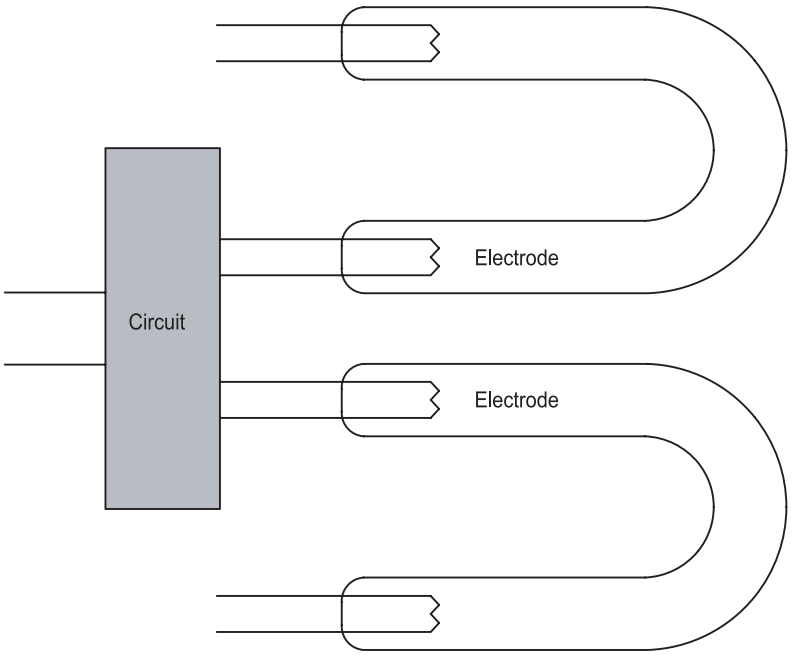
8.16.2 The fault conditions specified in Clause 8.16.1 shall be simulated as follows:

a) Disconnect one side of one cathode and then start the lamp. Repeat test for each cathode lead using a different lamp, if necessary.

b) Connect two separate wire lamps to the cathode circuit and then start the lamp. See Figure 8.2.

c) Start the lamp, wait five minutes, and then disconnect one side of a cathode. Repeat for each cathode lead wire using a different lamp, if necessary.

Figure 8.2
Fault conditions test diagram
(See Clause 8.16.2)



8.16.3 A self-ballasted lamp or adapter shall be placed on a knot-free pine board covered with a double layer of cheesecloth. A double layer of cheesecloth shall be draped over the unit.

8.16.4 The self-ballasted lamp or adapter shall be energized from a power supply of rated voltage and frequency. The unit shall operate under each fault condition until it fails to operate or for at least 1 hour after the fault is introduced. If at the end of one hour the unit exhibits abnormal behavior, then continue the test up to five hours. After each fault condition and before the cheesecloth is removed, the cheesecloth shall be inspected for evidence of ignition, burning, or strand separation.

8.16.5 The results of the test comply with this standard if:

a) The cheesecloth does not ignite or burn, nor shall the strands of the cheesecloth reach the point of separation.

b) There are no openings created in the enclosure that permit the accessibility probe described in Figure 9.3 to contact any part that is operating at risk of shock levels.

c) The sample complies with a dielectric voltage-withstand test between line and accessible metal parts.

8.17 End-of-lamp-life tests for fluorescent lamp adapters

8.17.1 General

8.17.1.1 Any one of the following three tests may be used to qualify a lamp adapter:

a) Asymmetric pulse test (described in Clause 8.17.2),

b) Asymmetric power dissipation test (described in Clause 8.17.3), and

c) Open filament test (described in Clause 8.17.4).

The results of each test are considered to be in compliance when the wattage or current is less than the limit specified in the individual test.

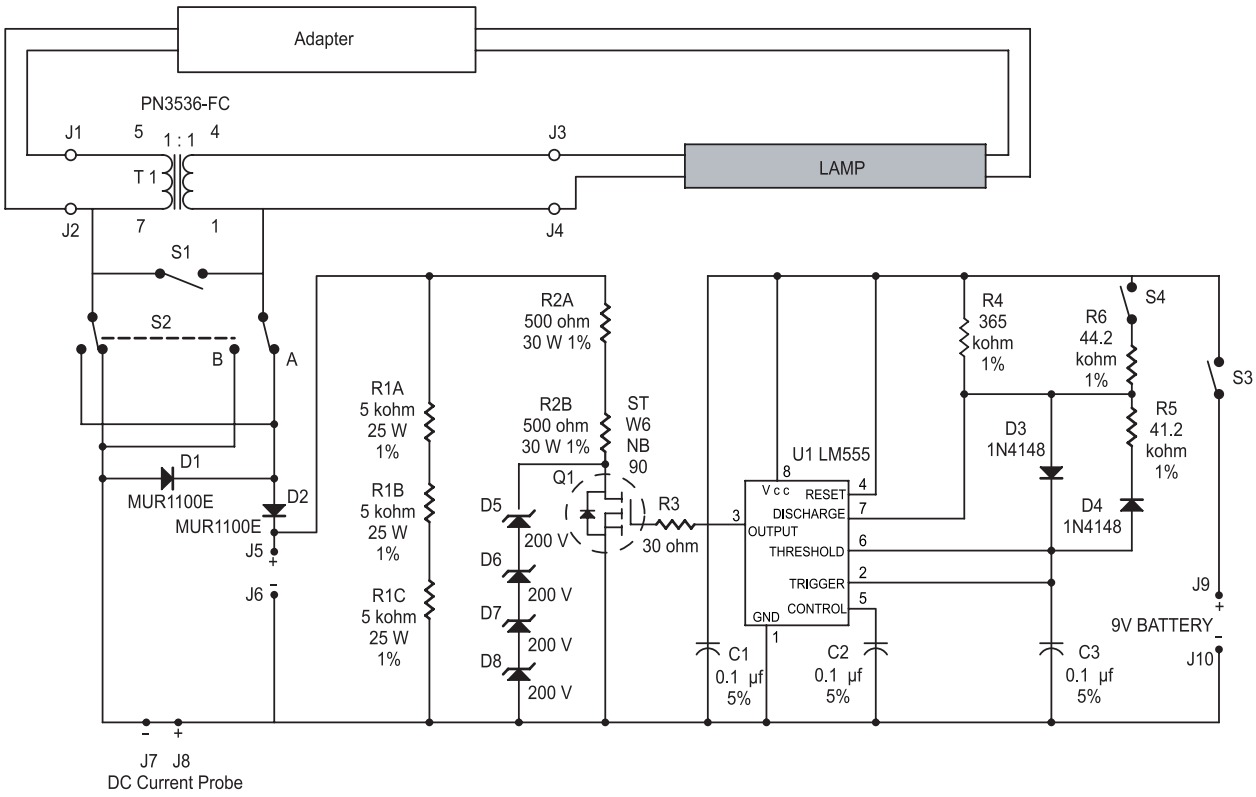
8.17.1.2 The manufacturer shall declare which one of the three tests will be used to test a given adapter, based on the design of that particular adapter circuit.

8.17.1.3 Lamps used in the adapter test circuits shall be new lamps seasoned for 100 h.

8.17.2 Asymmetric pulse test

8.17.2.1 Refer to the schematic diagram in Figure 8.3.

Figure 8.3
Asymmetric pulse test schematic
(See Clause 8.17.2.1)



Note – FET Q1 should be on for 3 ms and off for 3 ms when S4 is closed, and on for 27 ms and off for 3 ms when S4 is open.

8.17.2.2 The following values of maximum cathode power P_{max} apply:

a) For lamps with diameters 13 mm or smaller, P_{max} = 5.0 W, and

b) For lamps with diameters greater than 13 mm, P_{max} = 7.5 W

8.17.2.3 If only one connection per electrode is available at the ballast and/or lamp, T1 shall be removed, and then the ballast shall be connected to J2 and the lamp to J4. The ballast manufacturer should be asked which of the output terminals has to be connected to J4 and, in case two output terminals per electrode exist, whether they can be short-circuited or be bridged with a resistor. Conduct the test as follows:

a) Close switches S1 and S4, and set switch S2 to position A.

b) Turn on the ballast under test and allow lamp or lamps to warm up for 5 minutes.

c) Close S3, open S1, and wait for 15 seconds. Open S4 and wait for 15 seconds.

d) Measure the sum of the average power dissipated in the power resistors, R1A to R1C and R2A and R2B, and the Zener diodes D5 to D8.

Note: The power should be measured at the average value of the product of the voltage between terminals J5 and J6 times the current flowing from J8 to J7. The voltage should be measured with a differential voltage probe, and the current should be measured with a DC current probe. A digital oscilloscope can be used for the multiplication and averaging functions. If the ballast operates in a cycling mode, the averaging interval should be set to cover an integer number of cycles. (Each cycle is typically greater than 1 second.) The sampling rate and number of samples included in the calculations should be sufficient to avoid aliasing errors.

The power dissipation shall be below P_{max}. If the power dissipation is greater than P_{max}, the ballast has failed and the test is discontinued.

e) Close S1 and S4.

f) Set S2 to position B.

g) Repeat steps b, c, and d above. The ballast shall pass both position “A” and position “B” tests.

h) For multi-lamp ballasts, repeat steps a through g for each lamp position. A multi-lamp ballast shall pass the tests for each lamp position.

i) For ballasts that operate multiple lamp types (e.g., 26W, 32W, 42W, etc.) each lamp type specified shall be tested. Repeat steps a through h for each lamp type.

8.17.2.4 The following components are used in the asymmetric pulse test circuit:

U1 – 555 timer IC

T1 – 1:1 transformer (see Clause 8.17.2.5)

D1, D2 – ultra-fast recovery diode, 1000 V, 1 A, 75 ns

D3, D4 – signal diode, 75 V, 200 mA

D5 to D8 – Zener diode, 200 V

Q1 – Mosfet 900 V, 6 A

R1A to R1C – resistor, 5 kΩ, 25 W, 1%

R2A and R2B – resistor, 500 Ω, 30 W, 1%

S1, S3, and S4 – switch

S2 – switch, double

Battery – battery, 9 V

C1, C2, C3 – capacitor, 0.1 µF, 50 V, 5%

R3 – resistor, 30 Ω, ¼ W, 5%

R4 – resistor, 365 kΩ, ¼ W, 1%

R5 – resistor, 41.2 kΩ, ¼ W, 1%

R6 – resistor, 44.2 kΩ, ¼ W, 1%

8.17.2.5 The specification for the transformer (T1) listed in Clause 8.17.2.4 as follows:

Core – two EI187 (E19/8/5), core area 22.6 mm^2, P material or equivalent

Bobbin – 8-pin, horizontal mount

Primary winding – 38 turns, 26 AWG HN, 19 turns/layer, start pin 5, finish pin 7

Inter-winding insulation – 5 layers 3M #56 3/8 in. or equivalent

Secondary winding – 38 turns, 26 AWG HN, 19 turns/layer, start pin 4, finish pin 1

Wrapper – 2 layers 3M #56 3/8 in. or equivalent

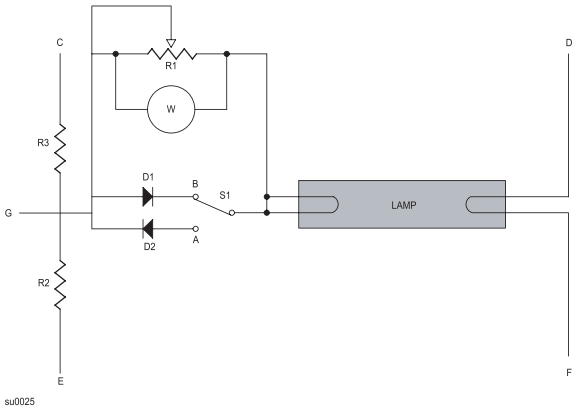
Inter-winding capacitance – Approximately 22 pF

HIPOT – 2500 V_{rms}

8.17.3 Asymmetric power test

8.17.3.1 Refer to the schematic diagram in Figure 8.4.

Figure 8.4
Asymmetric power test schematic
(See Clause 8.17.3.1)



Note 1 – R2 = R3 = Ω (this resistance is 1/2 resistance of hot cathode – refer to lamp data sheet)

Note 2 – C, D, E, and F represent cathode connections for the ballast

Note 3 – For instant start ballasts, connection G is connected to one terminal and the combined D and F are connected to the other terminal.

8.17.3.2 The test sequence shall be as follows:

a) Set switch S1 to position A.

b) Set resistance of resistor R1 to 0 (zero) Ω.

c) Start lamp or lamps by turning on power to ballast under test and allow lamp or lamps to warm up for 5 minutes.

d) Increase the resistance of R1 rapidly (within 15 seconds) until the power dissipated by resistor R1 equals the test wattage value of 10 W for lamps with diameters 13 mm or smaller, or 15 W for larger lamps. If the ballast limits the power in R1 to a value less than the test wattage, set R1 at the value that produces the maximum wattage. If the ballast switches off before reaching the test wattage, continue with e. If the ballast does not switch off and limits the power in R1 to a value less than the test wattage, set R1 at the value that produces the maximum wattage.

e) If the test wattage value was reached in step d, wait for an additional 30 seconds. Measure the power in R1.

The power dissipation in resistor R1 shall be below or equal to P_{max}. If the power dissipation in resistor R1 is greater than P_{max}, the ballast has failed and the test is discontinued.

f) Turn off power to ballast. Set switch S1 to position B.

g) Repeat test procedure steps c to e above. The ballast shall pass both position “A” and position “B” tests.

h) For multi-lamp ballasts, repeat test procedure, steps a through g for each lamp position. A multi-lamp ballast shall pass the tests for each lamp position.

i) For ballasts that operate multiple lamp types (e.g., 26W, 32W, 42W), each lamp type specified shall be tested. Repeat steps a to h for each lamp type.

8.17.3.3 The following components are used in the asymmetric power test:

R1 – adjustable resistor, 1 kΩ, 100 W in series with 5 kΩ, 100 W

R2, R3 – resistor, (value specified by manufacturer of the lamp under test), 5 W, 5%

D1, D2 – high voltage diodes, RGB30M

S1 – switch

8.17.4 Open filament test

8.17.4.1 Test selection

8.17.4.1.1 The adapter shall have adequate protection to prevent lamp base overheating at the end of the lamp life cycle under open filament conditions. Compliance is checked by either test procedure A or B as determined by the value of I_{max} below.

8.17.4.1.2 During the test the following values of maximum lamp current I_{max} apply:

a) For lamps with outside tube diameter of 13 mm or smaller, I_{max} = 1 mA, and

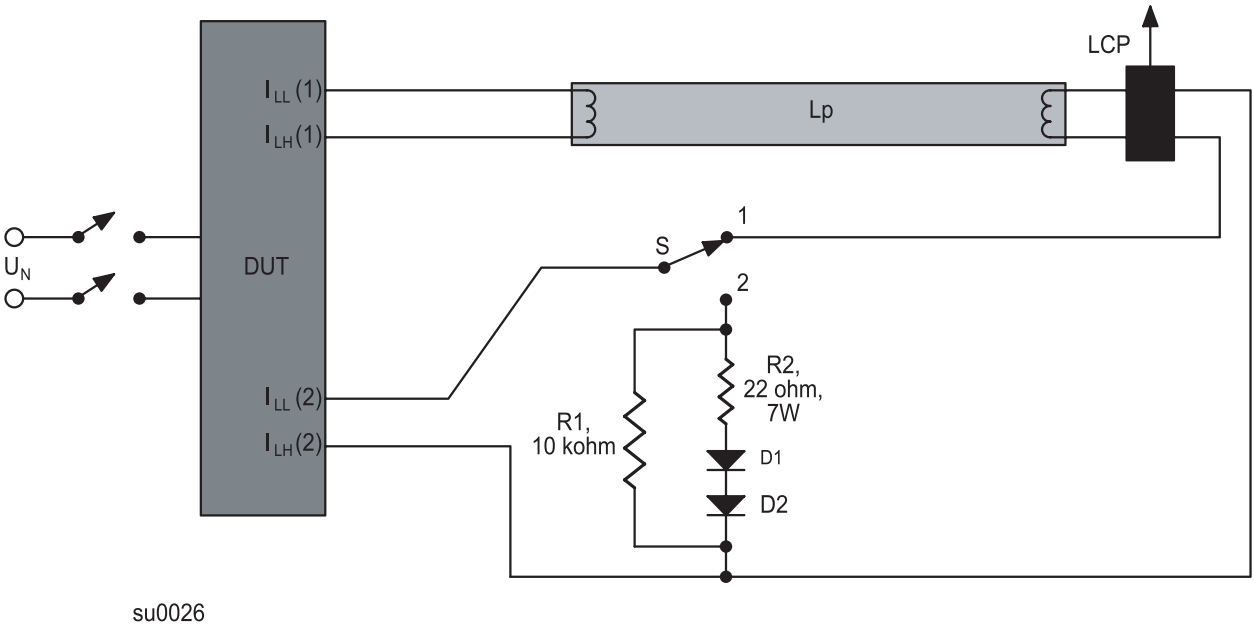
b) For lamps with outside tube diameter greater than 13 mm, I_{max} = 1.5 mA.

8.17.4.1.3 If these current values are exceeded, test procedure B shall be applied; otherwise test procedure A shall be applied.

8.17.4.2 Measurements to be carried out prior to test procedure A

8.17.4.2.1 Connect the circuit according to Figure 8.5.

Figure 8.5
Open filament test circuit: Electrode (1) check
(See Clauses 8.17.4.2.1, 8.17.3.2, and 8.17.4.4.1)



8.17.4.2.2 Determine the rms currents $I_{LL}(1)$, $I_{LH}(1)$, $I_{LL}(2)$, and $I_{LH}(2)$ at the adapter output terminals, by using a current probe, and mark the terminals respectively, where:

a) $I_{LL}(1)$ is the lower of the rms currents through lead-in wire of electrode 1,

b) $I_{LH}(1)$ is the higher of the rms currents through lead-in wire of electrode 1,

c) $I_{LL}(2)$ is the lower of the rms currents through lead-in wire of electrode 2, and

d) $I_{LH}(2)$ is the higher of the rms currents through lead-in wire of electrode 2.

8.17.4.3 Test procedure A

8.17.4.3.1 The test sequence shall be as follows:

a) Set S to position 1.

b) Turn on the adapter under test and allow lamp or lamps to warm up for 5 min.

c) Set S to position 2 and wait for 30 s.

d) Measure the rms current value of $I_{lamp} = I_{LH} - I_{LL}$ with the current probe near to the lamp end. If I_{lamp} is pulsing, the rms shall be computed over one complete pulse cycle including time off.

The lamp discharge current I_{lamp} shall not be greater than I_{max}.

If the lamp discharge current is greater than I_{max}, the adapter has failed, and the test is discontinued.

e) Connect the lamp to the adapter as shown in Figure 8.6. The following components are used in the open filament test circuit for test procedure A, electrode (2) check:

R1 – resistor, 10kΩ, 7 W

R2 – resistor, 22 Ω, 7 W

D1 and D2 – high voltage diodes, RGB30M

S – switch

Lp – lamp

LCP – lamp current probe

U_N – supply

DUT – device under test

f) Set S to position 1.

g) Turn on the adapter under test and allow lamp or lamps to warm up for 5 min.

h) Set S to position 2 and wait 30 s.

i) Measure rms current value of I_{lamp} with the current probe near to the lamp end. If I_{lamp} is pulsing, the rms value shall be computed over one complete pulse cycle including the off time.

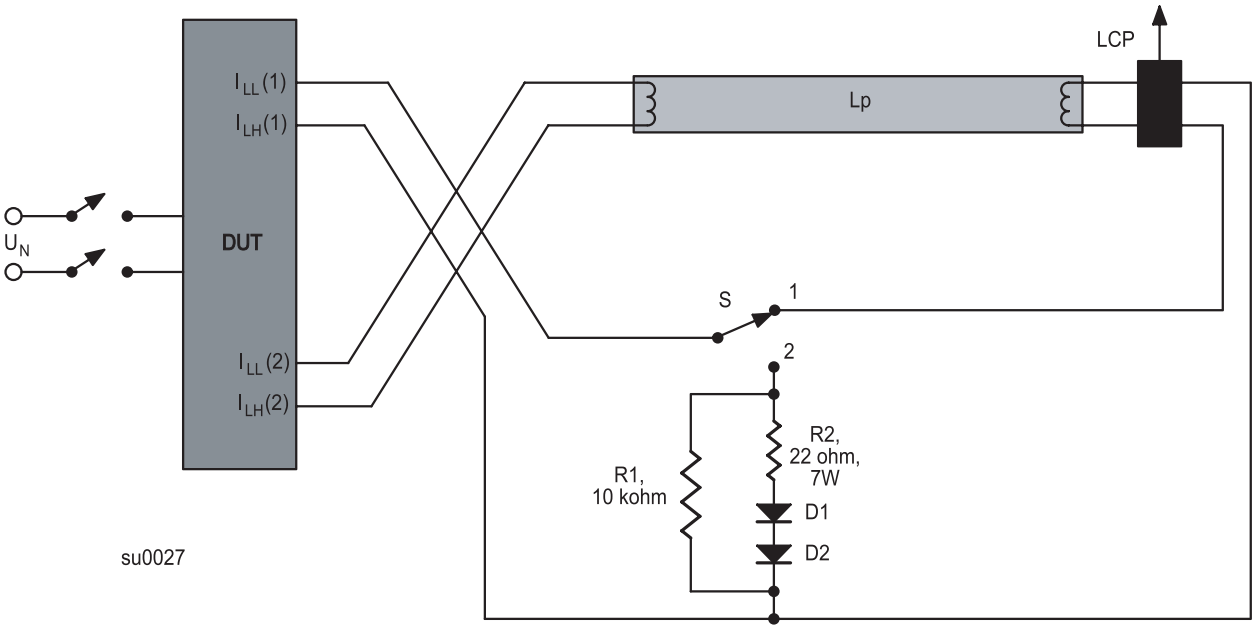
The lamp discharge current I_{lamp} shall not be greater than I_{max}.

j) For multi-lamp adapters, repeat test procedure steps a through i for each lamp position.

A multi-lamp device shall pass the tests for each lamp position.

k) For adapters that operate multiple lamp types (e.g. 26 W, 32 W, 42 W), each lamp type specified shall be tested. Repeat steps a through j for each lamp type.

Figure 8.6
Open filament test circuit: Electrode (2) check
(See Clauses 8.17.4.3.1, 8.17.4.4.1, and 8.17.4.4.2)



8.17.4.3.2 The following components are used in the open filament test circuit for test procedure A, electrode (1) check (see Figure 8.5):

R1 – resistor, 10kΩ, 7 W

R2 – resistor, 22 Ω, 7 W

D1 and D2 – high voltage diodes, RGB30M

S – switch

Lp – lamp

LCP – lamp current probe

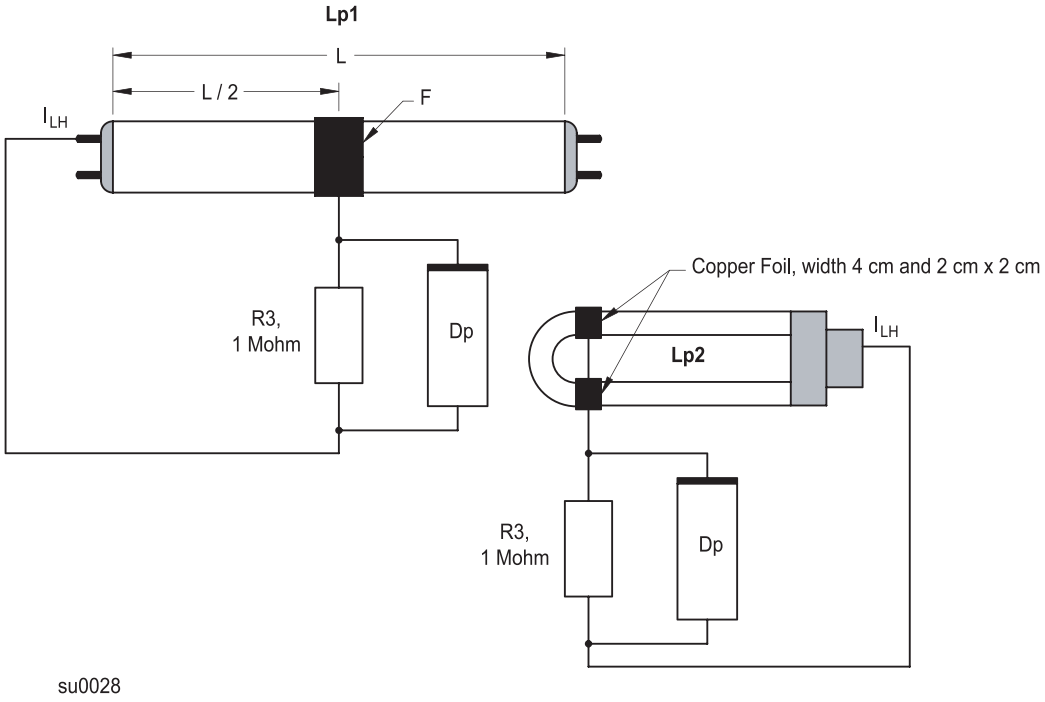
U_N – supply

DUT – device under test

8.17.4.4 Test procedure B

8.17.4.4.1 Connect the lamp as shown in Figures 8.5 and 8.6 with the measurement arrangement according to Figure 8.7. If the adapter has an isolation transformer, connect the 1 MΩ resistor to the corresponding terminal as defined in Clause 8.17.4.3.

Figure 8.7
Detection of lamp current
(See Clauses 8.17.4.4.1 and 8.17.4.4.2)



8.17.4.4.2 The test sequence shall be as follows:

a) Set S to position 1.

b) Turn on the ballast under test and allow lamp or lamps to warm up for 5 min.

c) Set S to position 2 and wait for 30 s.

d) Measure the rms voltage value with the differential probe placed as indicated in Figure 8.7. If the voltage is pulsing, the rms value shall be computed over one complete pulse cycle including the off time.

e) The voltage shall not be greater than 25 percent of the rated lamp voltage from the applicable ANSI or IEC lamp standard. If the lamp is not standardized, then the lamp voltage shall be declared by the manufacturer. If the voltage is greater than 25 percent, discontinue the test. Refer to Figure 8.6.

f) Repeat the test procedure steps a through d above.

g) For multi-lamp devices, repeat test procedure steps a through e for each lamp position.

A multi-lamp device shall pass the test for each lamp position in order to pass the end-of-life lamp test.

h) For adapters that operate multiple lamp types (e.g. 26 W, 32 W, 42 W), each lamp type specified shall be tested.

Repeat steps a) through f) for each lamp type. A multiple lamp adapter shall pass the test for each lamp type.

8.17.4.4.3 The following components are used in the open filament test circuit for test procedure B, the detection of lamp current:

R3 – resistor, 1 MΩ

Lp1 – lamp

Lp2 – lamp

Dp – differential probe, < 10 pF

8.18 End-of-life test for integral, self-ballasted fluorescent lamps – one filament emission-mix-free test

8.18.1 A self-ballasted lamp shall be tested as described in Clauses 8.18.2 to 8.18.5.

8.18.2 Six samples shall be used for the test. Three of the samples shall have no emission-mix on one lamp filament and the other three samples shall have no emission-mix on the other lamp filament.

8.18.3 During the test, the device shall be energized at the input voltage and frequency. The device shall be oriented base up unless the packaging clearly indicates the bulb is not to be operated in this orientation. The samples may be operated in an open environment.

8.18.4 The samples shall be observed during the test for any evidence of smoke, fire, or cracking of the bulb wall. The test shall be discontinued upon any evidence of fire.

8.18.5 The results of the test comply with this standard if:

a) Any flaming is contained in the enclosure,

b) There are no burn-through openings created in the enclosure,

c) There are no dislodged particles of glass larger than 3 mm (0.1 in),

d) The combined area of any charred black spots does not exceed 75 mm^2 (0.12 in^2) [not including the area described in (e)],

e) There is no charred black area around the tube wider than 3 mm (0.1 in) measured perpendicular to the bulb wall, and

f) No more than a small amount of smoke, similar to that of an overheated 1 W carbon resistor, is emitted.

9 Test Apparatus

9.1 General

9.1.1 Clause 9.1 summarizes test equipment and environmental conditions needed for the laboratory facility where testing would be conducted.

9.1.2 Unless otherwise specified, the tests shall be carried out at an ambient temperature of 20 °C to 30 °C with a relative humidity between 30 and 70%. Atmospheric pressure is not specified.

9.1.3 Test equipment shall be in a schedule of initial calibration and periodic re-calibration. The frequency of re-calibration for electronic instrumentation shall be as recommended by the instrument manufacturer, but not exceed 1 year between calibrations.

9.1.4 Test equipment shall have a method of specific identification, such as serial number or a unique laboratory numbering system, so that the equipment used for the test may be noted in the results of the test.

9.2 Instrumentation

9.2.1 The voltage in other than the supply circuit shall be measured using a voltmeter or voltmeter-multiplier combination having a resistance of not less than 10,000 Ω/V. Meters having higher input impedances shall be used if the impedance of the circuit under test warrants it. A voltmeter for measuring a supply circuit is not specified.

9.2.2 For determining values of voltage, a true rms indicating meter having a frequency response at least three times the frequency involved and having an adequate crest factor (ratio of peak to rms) shall be used. If applicable, consideration should be given to the DC component of the wave-shape. If a referee rms-voltage measurement is necessary, a meter with an input impedance of 10 MΩ shunted by 30 pF of capacitance shall be used.

9.2.3 If it is necessary to determine peak-voltage value, an oscilloscope with a high-impedance (10 MΩ minimum) input probe shall be used.

9.2.4 For thermocouple measurements, either a thermocouple potentiometer or an electronic instrument shall be used. An electronic instrument shall have an accuracy at least as good as the thermocouples described in Clause 9.3.

9.3 Thermocouples

9.3.1 Thermocouples shall consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). It is standard practice to employ thermocouples consisting of 30 AWG iron-constantan (Type J) wires and a potentiometer-type or electronic instrument; and such equipment shall be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire shall conform to the requirements for thermocouples as listed in the table of special limits of error of thermocouples in ANSI/ISA MC96.1.

9.3.2 Thermocouples consisting of chromel-alumel (Type K) or copper-constantan (Type T) wires may be used if it is determined that high-frequency ballast operation results in eddy current heating of iron-constantan thermocouples.

9.4 Plywood test box material

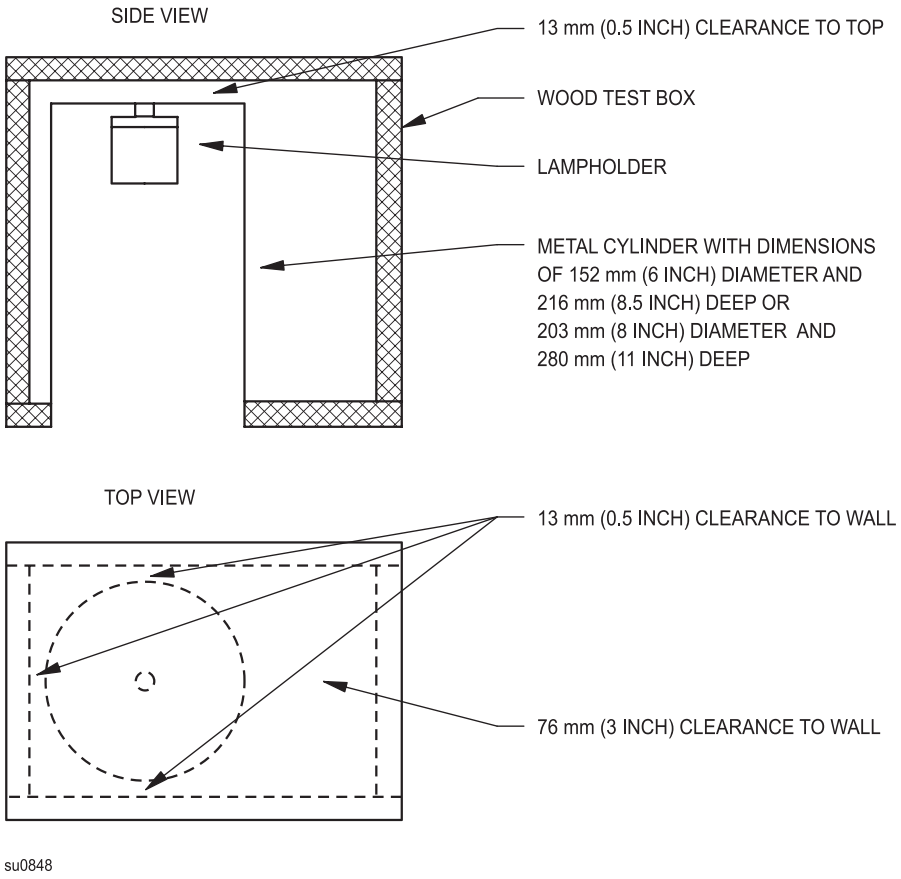
9.4.1 The plywood used for constructing temperature test boxes shall be 12-mm (1/2-in trade size) thick with at least one side that has all voids filled and sanded.

9.5 Temperature test box

9.5.1 Test apparatus for a device with an input rating less than 50 W

9.5.1.1 The test fixture shall be a steel or aluminum cylinder, closed at the top. The smaller cylinder shall be 152 mm (6 in) in diameter and 216 mm (8.5 in) deep, while the larger cylinder shall be 203 mm (8 in) in diameter and 280 mm (11 in) deep. The cylinders shall be fabricated of steel or aluminum, having a thickness between 0.76 and 1.27 mm (0.03 and 0.05 in). The cylinders shall be painted white on all sides. Each cylinder shall be installed in a rectangular test box having four sides, a top, and bottom. The cylinder shall be flush to the test box bottom and the wood bottom shall have an opening the size of the cylinder diameter. The test box sides shall be constructed of plywood described in Clause 9.4.1. Three sides and the top shall be 13 mm (0.5 in) from the nearest part of the cylinder. The fourth side shall be 76 mm (3 in) from the nearest part of the cylinder. The supply lampholder shall be porcelain coated and have a cast metal cap bearing against the cylinder top. See Figure 9.1.

Figure 9.1
Small temperature test box
(See Clauses 8.5.3, 8.5.6, and 9.5.1.1)



su0848

9.5.2 Test apparatus for a device with an input rating greater than 50 W for an enclosed lamp compartment

9.5.2.1 The device shall be tested in the enclosed test fixture described below for the normal temperature test. The sides and top of the test fixture shall be constructed of 12.7 mm (1/2 in trade size) thick minimum grade C-D or better plywood. The bottom shall be closed off with a 2.5 mm (0.1 in) thick piece of window glass of appropriate size.

9.5.2.2 The test fixture shall have a square cross-section. The dimensions of the sides of the square shall be specified by the self-ballasted lamp manufacturer and marked on the self-ballasted lamp. The dimensions shall be in millimetres. The height of the box shall be equal to the overall length of the self-ballasted lamp plus 13 mm (0.5 in).

9.5.2.3 A lampholder shall be mounted to the inside top of the center of the box and 0.82 mm^2 (18 AWG) insulated conductors of suitable temperature and voltage rating supply power shall be connected to it. The test fixture shall be suspended (by chain, cable, or similar means) in a draft-free room with the side of the test fixture closed off by glass facing the floor. The box shall be located so that each exterior surface is at least 1 m from the floor, walls, or ceiling of the draft-free test room.

9.5.3 Normal temperature test apparatus for a device with an input rating greater than 50 W for an open luminaire

9.5.3.1 The temperature test apparatus shown in Figure 9.2 shall be constructed as follows:

a) Wooden parts of the structure shall be secured together with wood screws or nails.

b) Wooden parts of the structure shall be as follows:

1) The face and back shall be plywood conforming to Clause 9.4.1, 1.22 m (48 in) square.

2) The sides shall be 38 mm × 140 mm (2 in × 6 in trade size) wooden members.

3) The ends shall be 19 mm × 140 mm (1 in × 6 in trade size) wooden members.

4) The inside supports shall be 38 mm × 89 mm (2 in × 4 in trade size) wooden members.

c) A metal octagonal outlet box, 102 mm × 38 mm (4 in × 1-1/2 in trade size), shall be securely mounted in the center of the plywood panel, projecting through and flush with the outer face. One method for mounting the box is steel angle brackets, attached to opposite sides of the box and secured with wood screws to the inside of the plywood panel.

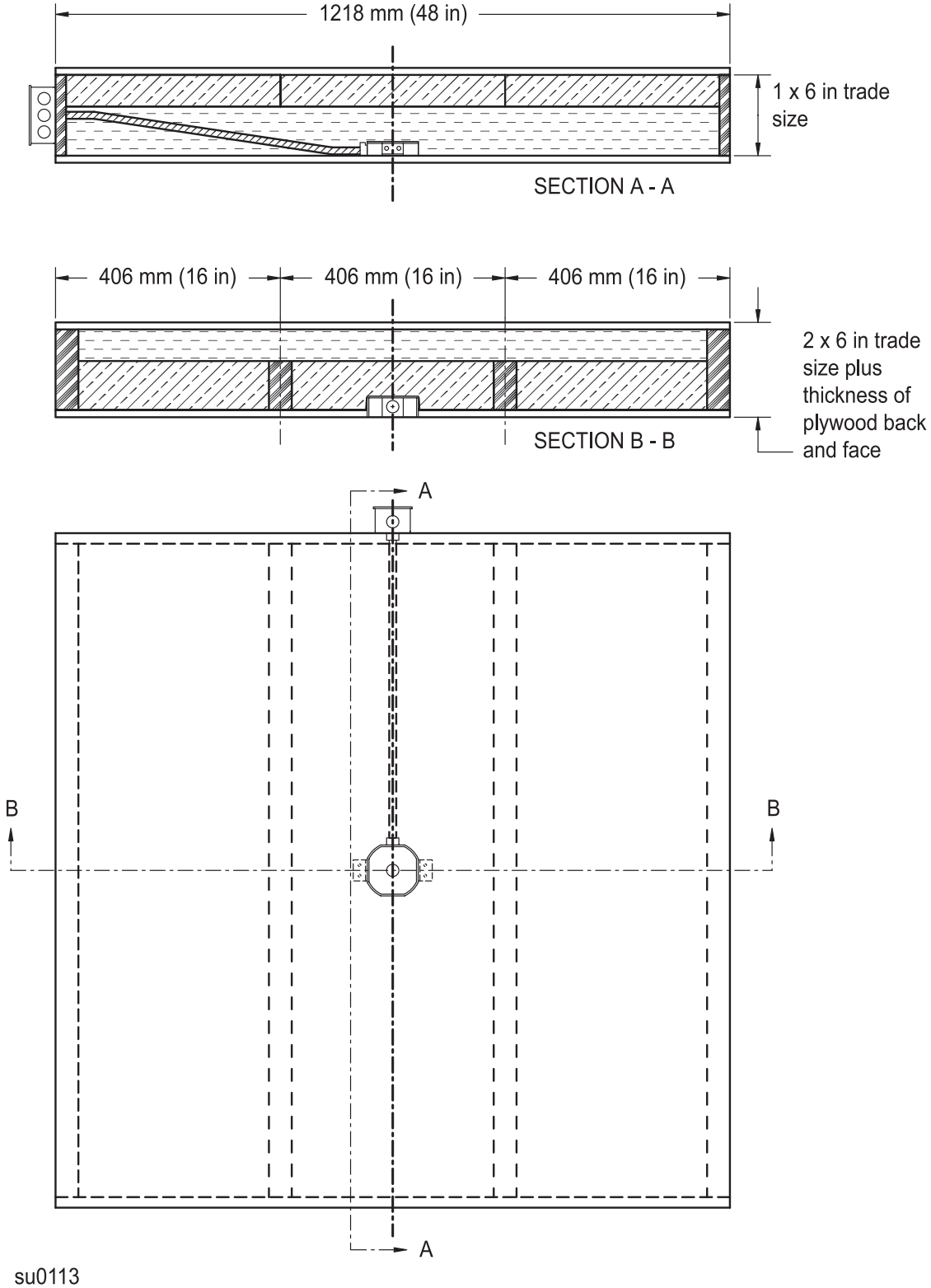
d) An optional metal surface utility box with cover may be mounted to the side of the structure to facilitate ease of making branch circuit connections. A 102 mm × 63.5 mm × 44.5 mm (4 in × 2-1/2 in × 1-3/4 in trade size) box has been found suitable for this purpose.

e) Flexible metal or non-metallic conduit may be installed between the outlet box and the utility box to facilitate replacing damaged conductors.

f) Wiring shall consist of one white and one black 2.08 mm^2 (14 AWG) conductor of any type and one 1.31 mm^2 (16 AWG) or larger conductor, bonding the boxes together.

g) The test ceiling apparatus shall be filled with two layers of faced or unfaced glass fiber insulation batts positioned at 90 degrees to each other. The insulation batts shall be approximately 89 mm (3.5 in) thick and RSI 1.4 to RSI 1.9 (R8 to R11) positioned directly in contact with the outlet box and slit to completely surround the flexible metal conduit.

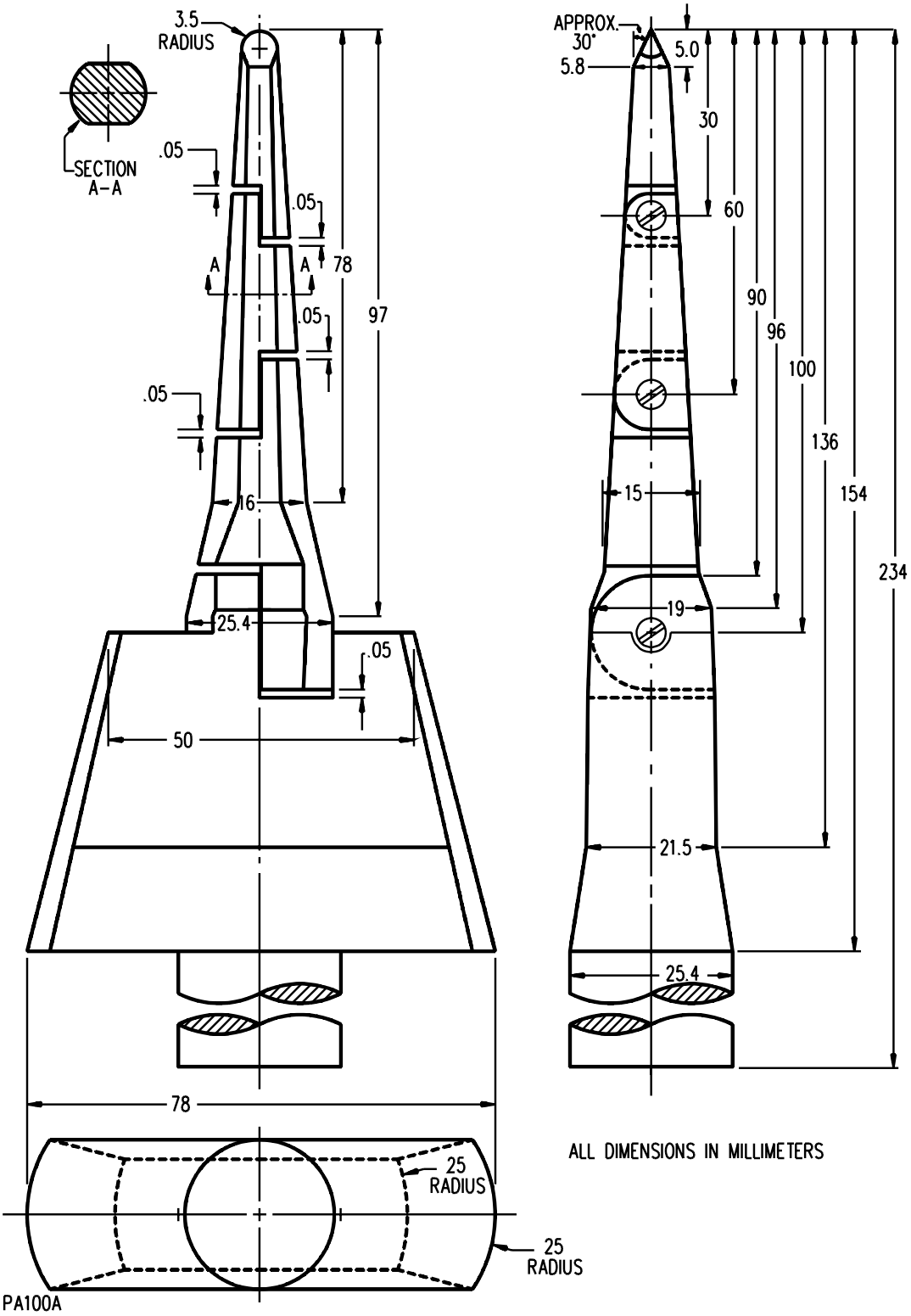
Figure 9.2
Insulated test ceiling for devices rated greater than 50 W and for an open luminaire
(See Clauses 8.5.3 and 9.5.3)



9.6 Articulated probe

9.6.1 See Figure 9.3 for articulated test probe specifications.

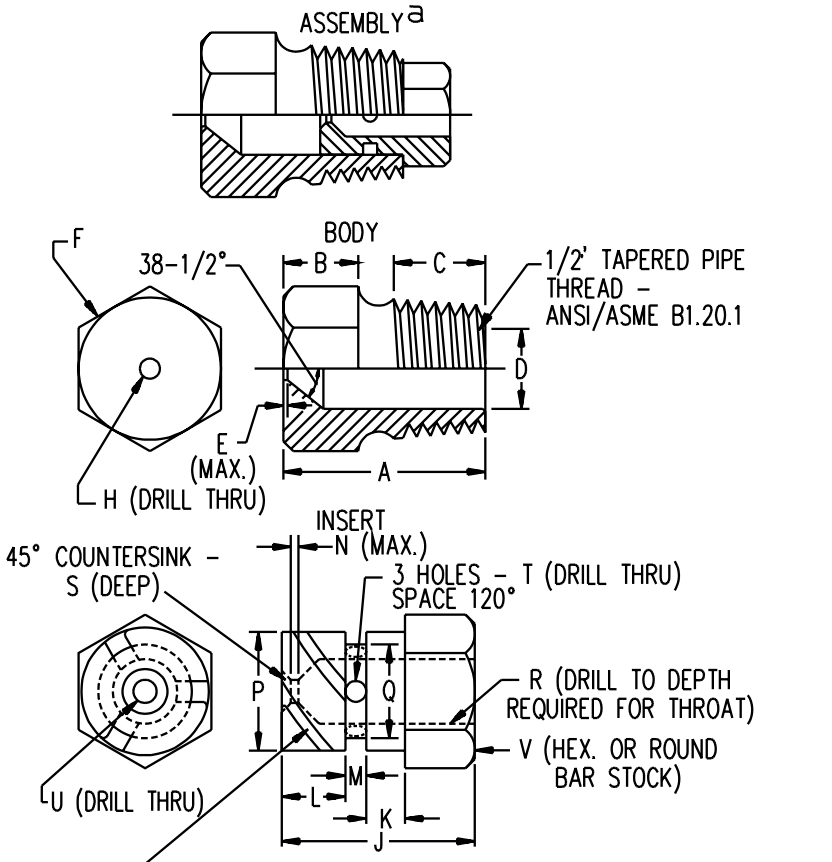
Figure 9.3
Articulated test probe
(See Clauses 8.8.3, 8.16.5, 9.6.1, and SA8.8.2)



9.7 Water spray apparatus

9.7.1 The water spray test apparatus shall consist of three spray heads constructed in accordance with the details specified in Figure 9.4 and mounted in a water supply pipe rack as illustrated in Figure 9.5. The water pressure shall be maintained at each spray head at approximately 34.5 kPa (5 psi). The distance between the center nozzle and the device shall be approximately 1.4 m (4.59 ft). The device shall be brought into the focal area of the three spray heads in such a position and under such conditions that water will be most likely to enter, except that consideration shall be given to the normal mounting position.

Figure 9.4
Spray head assembly
(See Clause 9.7.1)

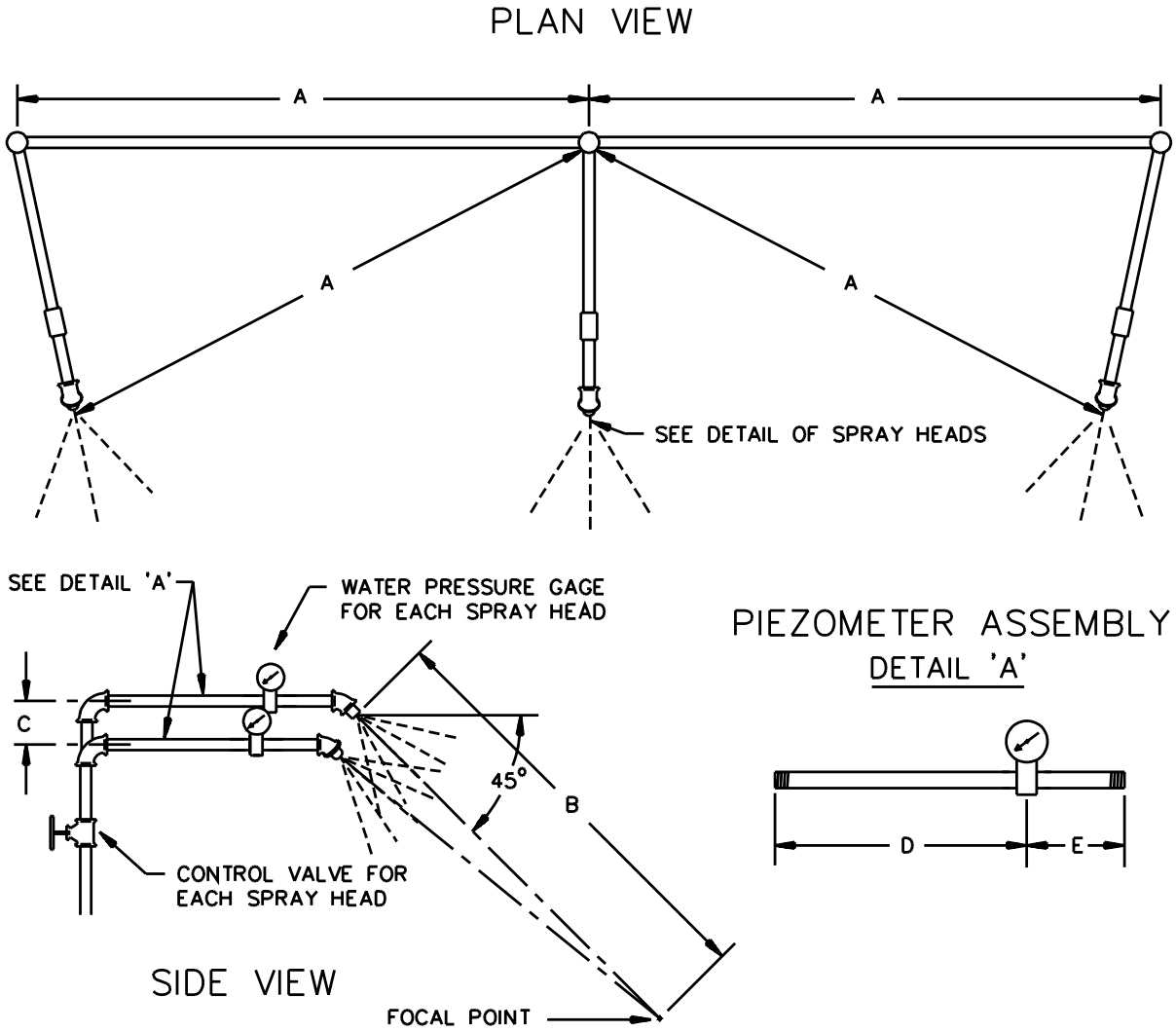


Item	mm	inch	Item	mm	inch
A	31.0	1–7/32	N	0.80	1/32
B	11.0	7/16	P	14.61	.575
C	14.0	9/16		14.63	.576
D	14.68	.578	Q	11.51	.453
	14.73	.580		11.53	.454
E	0.40	1/64	R	6.35	1/4
F	c	c	S	0.80	1/32
G	1.52	.06	T	2.80	(No. 35) [b]
H	5.0	(No.9) [b]	U	2.50	(No. 40) [b]
J	18.3	23/32	V	16.0	5/8
K	3.97	5/32	W	1.52	0.06
L	6.35	1/4			
M	2.38	3/32			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories
[b] ANSI B94.11M Drill Size
[c] Optional – To serve as a wrench grip.

RT100F

Figure 9.5
Spray head pipe rack
(See Clause 9.7.1)



Item	mm	inch
A	710	28
B	1400	55
C	55	2–1/4
D	230	9
E	75	3

RT101F

9.8 Cheesecloth

9.8.1 The cheesecloth shall be bleached cheesecloth, 914 mm (36 in) wide, running 26 to 28 m^2/kg (14 to 15 yd^2/lb) and having what is known in trade as a count 32 by 28. That is, for any square centimetre, 13 threads in one direction and 11 in the other direction (for any square inch, 32 threads in one direction and 28 in the other direction).

10 Device Markings

10.1 General

10.1.1 A device shall be legibly marked using one or more of the following methods:

a) Lettering on a pressure-sensitive label,

b) Ink-jet lettering,

c) Ink-stamped machine lettering,

d) Ink-hand stamped lettering,

e) Indelibly printed lettering,

f) Die-stamped lettering,

g) Molded (recessed) or embossed (raised) lettering,

h) Molded-or cast lettering,

i) Etched lettering in metal,

j) Laser printing, and

k) Silk screening and transfer printing.

10.1.2 A pictogram in accordance with Annex F may be used as a substitute for the corresponding text of Table 10.1 and shall be the subject of special inspection. When a pictogram is used instead of text marking on a device, the pictogram, along with the corresponding text, shall appear on an instruction sheet or device packaging.

10.1.3 A marking shall be of the minimum size (S____) and in the location (L____) shown in the “Format” column of Table 10.1 and as defined in Tables 10.2 and 10.3.

10.1.4 “Verbatim” in the “Text” column of Table 10.1 indicates that the marking shall consist of only the exact words shown or a marking including these words and conveying the original intent. Alternative wording for other markings in the table may be used subject to evaluation.

In Canada, bilingual marking is the jurisdiction of Canadian provincial regulatory authorities, which may require marking to also be in French, as shown in Annex B.

In Mexico, all markings shall include Spanish, as shown in Annex C.

10.1.5 All markings shall have lettering in which:

a) The precautionary signal word (Item 8) is at least 2.0 mm (0.08 in) high,

b) The text is at least 1.3 mm (0.05 in) high and contrasting in color to the background, and

c) If molded or stamped in a material, the text is at least 2.0 mm (0.08 in) high, and if not contrasting in color, a depth or raised height of at least 0.5 mm (0.02 in).

10.1.6 Pressure-sensitive labels of the permanent type (Type P) that are secured by adhesive shall be in accordance with CSA C22.2 No. 0.15 or UL 969. The adhesive of the pressure-sensitive labels shall be suitable for the application surface, temperature, and environment.

10.2 Identifications and ratings

10.2.1 A device shall be marked with the following:

a) Identification of the company responsible for the product, in accordance with Table 10.1, Item 1. The identification may be in a traceable code if the device is identified by a brand or trademark owned by a private labeler.

b) A catalog number, model number, series number, or other similar designation in accordance with Table 10.1, Item 2,

c) A date code or other dating period of manufacture not exceeding any three consecutive months, in accordance with Table 10.1, Item 3. The date marking may appear on the surface of the device or lamp base screw shell and may be abbreviated or appear in a nationally accepted conventional code or in a code affirmed by the manufacturer, if it:

1) Does not repeat in less than 10 years, and

2) Does not require reference to the production records of the manufacturer to determine when the product was manufactured, and

d) Factory identification, if more than one location, in accordance with Table 10.1, Item 4.

Table 10.1
List of required markings
(See Clauses 6.10.1, 6.10.2, 6.10.3, 7.1.1, 7.2.1, 7.3.1, 8.2.2, 8.5.3, 8.5.5, 8.5.6, 8.12.1, 8.14.1, 10.1.2 to 10.1.4, 10.2, 10.4, and F.1)

Item	Product markings	Text	Format	Text reference
1	**Manufacturer's identification**		S13L1	10.2.1(a)
2	**Catalog number or similar product designation**		S13L1	10.2.1(b)
3	**Date marking (may be in code)**		S13L1	10.2.1(c)
4	**Factory identification, if more than one (may be in code)**		S13L1	10.2.1(d)
5	**____ VOLTS ____ AMPS _____ WATTS ____ HERTZ or ____ V _____ A ____ W ____ Hz**		S13L1	10.2.2
6	**USE WITH LAMP OF _____ WATTS**		S13L1	10.2.3
7	**HIGH POWER FACTOR or HPF**		S13L1	10.2.5
8	**CAUTION**	Verbatim	S20L1	6.10.1, 6.10.2(a)
9	**RISK OF ELECTRIC SHOCK – USE IN DRY LOCATION ONLY or ELECTRIC SHOCK RISK – ONLY FOR DRY LOCATIONS**	Verbatim	S13L1	7.1.1
10	**SUITABLE FOR DAMP LOCATIONS, or FOR DAMP LOCATIONS, or RISK OF ELECTRIC SHOCK – DO NOT USE WHERE DIRECTLY EXPOSED TO WATER**	Verbatim	S13L1	7.2.1
11	**SUITABLE FOR WET LOCATIONS or FOR WET LOCATIONS**	Verbatim	S13L1	7.3.1
12	**SUITABLE FOR WET LOCATIONS – (to be followed by words describing the restricted positioning) as tested in 8.14, "SUITABLE" is optional**		S13L1	7.3.1, 8.14.1
13	**DO NOT USE WITH DIMMERS or NOT FOR USE WITH DIMMERS**		S13L1	8.12.1
14	**NOT FOR USE IN TOTALLY ENCLOSED LUMINAIRES or NOT FOR TOTALLY ENCLOSED LUMINAIRES**		S13L1	8.5.6, 10.2.5
15	**MAX ___WATTS TYPE _____ SHIELDED or MAX ____ W TYPE ___ SHIELDED (for adapters with tungsten-halogen lamps)**	Verbatim	S20L1	6.10.2
16	**MAX ___WATTS TYPE _____or MAX ____ W TYPE ___ (for adapters with tungsten-halogen lamps)**	Verbatim	S20L1	6.10.1
17	**SUITABLE FOR OPEN LUMINAIRES (for adapters with tungsten-halogen lamps)**	Verbatim	S13L1	6.10.3
18	**"Hg" (In a circle)**	"Hg" verbatim, circle is a graphical element	S20L1	10.2.6
	Instructions General			
19	**ADDED WEIGHT OF THE DEVICE MAY CAUSE INSTABILITY OF A FREE-STANDING PORTABLE LUMINAIRE**		L2	10.4.1
20	**USE ONLY WITH A PORTABLE TABLE LUMINAIRE THAT IS PROVIDED WITH A SHADE**		L2	10.4.1
21	**USE IN PORTABLE TABLE LUMINAIRES IN WHICH THE DISTANCE FROM THE BOTTOM OF THE BASE TO THE TOP OF THE LAMPHOLDER DOES NOT EXCEED THREE (3) TIMES THE MINIMUM BASE DIAMETER**		L2	10.4.3
22	**THIS DEVICE IS NOT INTENDED FOR USE WITH EMERGENCY EXITS or NOT FOR EMERGENCY LIGHTING**		L2	1.5 and 10.4.4
23	**SUITABLE FOR USE IN ENCLOSED LUMINAIRES**	Verbatim	S28L1	8.5.3(e)

Table 10.1 Continued on Next Page

Table 10.1 Continued

Item	Product markings	Text	Format	Text reference
24	**MIN. LAMP COMPARTMENT DIMENSIONS _(L)_ x (W)_ mm**	Verbatim	S28L1	8.5.3(e)
25	**USE IN OPEN LUMINAIRE ONLY**	Verbatim	S28L1	8.5.3(e)
26	**USE ONLY IN MODEL (model number) MANUFACTURED BY (manufacturer)**	Verbatim	S28L1	8.5.3(e)
27	**"Hg" (In a circle)** **"LAMP CONTAINS MERCURY"** **www.lamprecycle.org or www.epa.gov/bulbrecycling** **(Optional) "Manage in Accord with Disposal Laws"**	"Hg" verbatim, circle is a graphical element	S20L2	10.2.6
Note: The text shown in the table does not represent the actual minimum size and typestyle required. Text in parentheses ( ) is descriptive or informative and not part of the actual marking notice.				

Table 10.2
Format minimum size designations for marking height and type face
(See Clause 10.1.3)

Size designation	Letter height mm (in)	Font size	Font type face uppercase
S13	1.3 (0.051)	5	Universal bold Arial bold Helvetica bold Zurich BT bold Sans Serif
S20	2.0 (0.079)	7.5	
S28	2.8 (0.110)	11	

Table 10.3
Format location designation for marking
(See Clause 10.1.3)

Location designation	Description	Marking
L1	On the product	Type P
L2	On smallest unit packaging, point-of-sale package, carton, or instruction sheet	Type T

Notes:

Type P designates a permanent marking that is intended to remain in the applied position for the lifetime of the device under conditions of normal use. It provides information required for the user maintenance over the expected life of the device. If a label is used, it must be made of material that complies with Clause 10.1.6.

Type T designates a temporary label, instruction sheet, or tag that provides installation instruction and information not required after installation. It is made of printed matter with or without attachment to the device.

10.2.2 A device shall be marked with an electrical input rating in volts, hertz, wattage, and current in accordance with Table 10.1, Item 5. Hertz can be omitted if volts is expressed as "VAC" and the device has been evaluated for 60 Hertz, or if volts is expressed as "VDC."

10.2.3 A lamp adapter shall be marked with a wattage rating as specified in Table 10.1, Item 6.

10.2.4 A device with a power factor rating greater than 0.90 may be marked in accordance with Table 10.1, Item 7.

10.2.5 Unless the device is tested with the lens as described in Clause 8.5.6, the device shall be marked in accordance with Table 10.1, Item 14.

10.2.6 In the United States, self-ballasted fluorescent lamps shall be marked regarding their mercury content (see Item 18 of Table 10.1). The smallest unit packaging, point-of-sale package, carton, or "stuffer sheet" packed with lamp shall contain the marking described in Table 10.1, Item 27.

In Canada and Mexico, these requirements do not apply.

10.3 Marking requirements in Mexico

10.3.1 In Mexico, markings and labels on devices or packaging shall meet the requirements of Clauses 10.3.2 to 10.3.4 as applicable.

10.3.2 In Mexico, markings and labels on devices or packaging shall meet the following requirements:

a) The use of a period as a decimal point shall not be used. A comma shall be used as a decimal point.

b) Magnitudes less than the unit shall be represented with a zero followed by #, where # equals magnitude (for example, 90 cm = 0,90 m).

c) Letter size shall not apply to any marking.

d) Where applicable, input voltages (V) and current symbols shall be:

1) c.a. or AC or ~

2) c.d. or DC.

10.3.3 In Mexico, devices shall be marked with the following:

a) The name or trademark, model, or manner in which the manufacturer or importer identifies the product,

b) Nominal input voltage, frequency, wattage, and current,

c) Date marking or code form,

d) The type of lamp and wattage in watts for adapters, and

e) A statement that identifies the origin of the product.

Notes:

1) The frequency can be omitted if the ballast is an electronic circuit that works independently of the input frequency within an interval from 50 Hertz to 60 Hertz.

2) If the product is marked with the input wattage and the power factor is 0,9 or greater, the current can be omitted.

3) The manufacturing date can be brief or use a code designated by the manufacturer.

f) A device that is not intended to be used in a dimming circuit shall be marked “Do not use with dimmers.”

g) A device can be marked as “High Power Factor” or “HPF” if the power factor measured is 0,9 or greater.

10.3.4 In Mexico, the packaging shall include the following:

a) The graphical representation or product name, unless this is obvious,

b) The national manufacturer or importer’s name, address, telephone number, and telex number,

c) The name or trademark, model number, or manner in which the manufacturer or importer identifies the product,

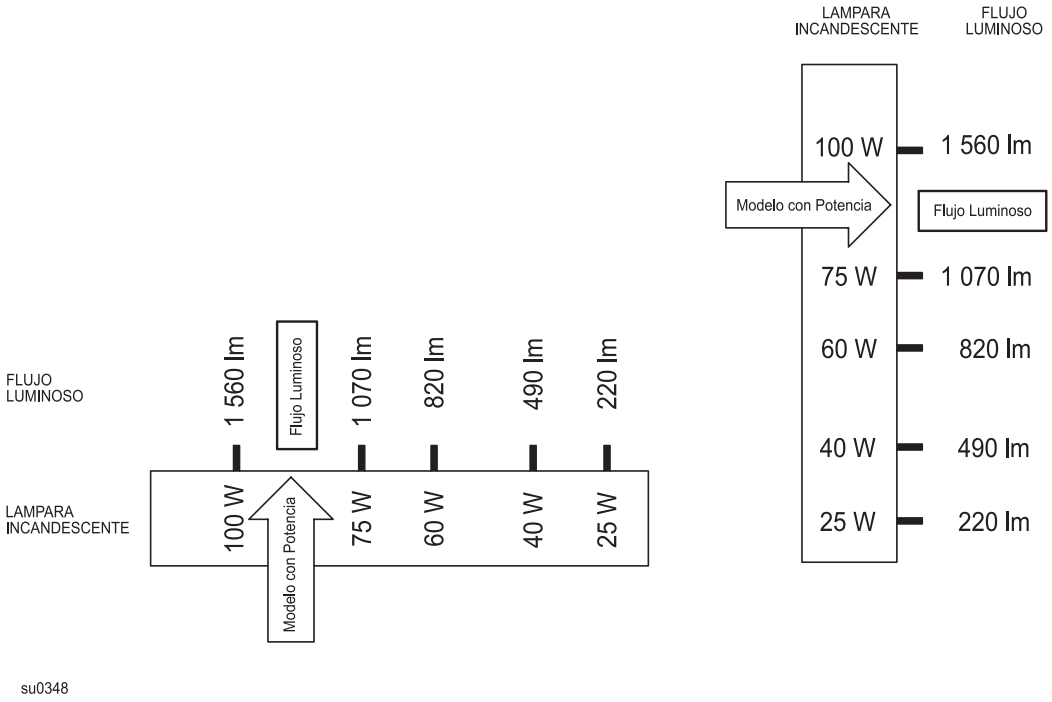
d) Nominal input voltage, frequency, wattage,

e) Number of pieces per carton.

f) Comparative graphic scale that indicates the equivalence with respect to incandescent lamps being replaced, with exception of reflector type lamps (see Figure 10.1), and

g) Average lamp life expressed in hours.

Figure 10.1
Graphic scale of luminous flux
(See Clause 10.3.4)



10.4 Instructions

10.4.1 A device weighing over 200 g (0.44 lbs) shall be provided with instructions in accordance with Table 10.1, Items 19 and 20.

10.4.2 A device, typically not intended for use in free-standing portable luminaires, such as a PAR- or R-shaped bulb, is not required to comply with Clause 10.4.1.

10.4.3 A device employing a lamp, such as a circular lamp, that extends outside of the harp of a portable luminaire shall be provided with an instruction in accordance with Table 10.1, Item 21, or shall be marked as required by Clause 10.4.1.

10.4.4 The instructions shall include the statement in Table 10.1, Item 22.

No Text on This Page

SUPPLEMENT SA - SUPPLEMENTAL REQUIREMENTS FOR LIGHT-EMITTING DIODES (LED)

SA1 Scope

SA1.1 Clause 1 applies and as amended below.

SA1.2 The text in the main body of this standard, along with this supplement, make up requirements for devices employing light-emitting-diode (LED) lamp technologies.

SA1.3 Where the requirements of any of the clauses of the main text are referenced in this supplement by the phrase “The requirements of clause ___ apply”, this phrase is to be interpreted as meaning that all requirements of the clause or paragraph of main text apply, except where it is clearly non-applicable to the product being evaluated.

SA1.4 The text in the main body of this standard using the word “ballast” is understood to also comprise LED drivers. The text in the main body of this standard using the word “lamp” is understood to also comprise LED arrays.

SA1.5 At various points in this supplement references are made to UL 8750 or CSA C22.2 No. 250.13.

SA1.6 These requirements cover:

a) Self-contained LED lamps, with control circuitry and driver, rated 120 to 347 V AC nominal for connection to screw-, pin-base, and recessed single contact (RSC or R7) lampholders,

b) Devices for replacement of an ANSI standardized fluorescent lamp, and consisting of light-emitting-diode (LED) lamp technologies, with control circuitry, and a driver or power supply. The LED driver and control circuitry will be either integral with the lamp or remote from the lamp – see SA6.13, and,

c) Component LED lamps, with or without control circuitry, an ANSI base other than bases mentioned in (1), for connection to LED driver having a low voltage output, such as replacement for tungsten-halogen, MR11 and MR16 shaped lamps – see SA6.14.

SA1.7 These requirements do not cover LEDs that are integral components and which form a non-replaceable part of a luminaire and which cannot be tested separately from the luminaire.

SA1.8 LED light sources having a means of supply connection other than lamp bases described above, are evaluated using requirements in UL 8750 or CSA C22.2 No. 250.13.

SA2 Reference Publications

SA2.1 Publications from Clause 2 apply.

SA3 Definitions

SA3.1 Terms from Clause 3 apply and as amended below.

SA3.2 BASIC INSULATION – electrical insulation of fiber or other polymeric material. Fiber and polymeric insulating materials are evaluated for moisture and puncture resistance, and electrical dielectric properties. Polymeric materials are additionally evaluated for electrical support properties sufficient for the application.

SA3.3 BARRIER – a part of the device intended to physically limit access to parts that pose a risk of electric shock. A barrier can be an insulating material in contact with other conductive parts or a conductive material isolated from other conductive parts.

SA3.4 CIRCUIT, CLASS 2 – a circuit of a low voltage and limited power nature such that the circuit components can be installed with the simplified installation manner described in Article 725 of the ANSI/ NFPA 70 for the United States, or Section 16 of Canadian Electrical Code, Part I, in Canada. The circuit supplied by an isolating source complies with the electrical limits and test requirements of:

a) UL 1310, or the Class 2 requirements of the UL 5085-3 for the United States, or

b) CAN/CSA-C22.2 No. 223, or the Class 2 requirements of the CSA C22.2 No. 66.1 for Canada.

Note: For the purposes of this standard, Limited Power Sources complying with UL 60950-1 or CSA C22.2 No. 60950-1 are deemed to be equivalent to Class 2 power supplies with respect to risk of electric shock and risk or fire.

SA3.5 DIRECT CURRENT (DC) – a voltage or current waveform where the instantaneous value does not vary.

SA3.6 LED ARRAY (LED MODULE) – an assembly of one or more discrete LED electronic components on a printed circuit board, typically with optics and additional thermal, mechanical, and electrical interfaces.

SA3.7 LED DRIVER – a power source and control circuitry to control the voltage or current to LEDs. The control circuitry can range from a simple (bridge rectifier and resistor) to complex (incorporating power factor control, constant voltage or constant current outputs, and the like).

SA3.8 LED LAMP, COMPONENT – an LED device without integral power source and with an ANSI standardized base designed for connection to a luminaire. The bulb can take the shape of an incandescent lamp it is intended to replace, such as MR-16.

SA3.9 LED LAMP, SELF-CONTAINED (INTEGRATED) – a device with an LED array, an integrated driver, and an ANSI standardized base that is designed to connect to a supply branch circuit via an ANSI standardized lampholder. In North America, a “standardized base” refers to an ANSI standard base.

Note: In Canada, tubular self-contained LED lamps may be connected to non-ANSI standardized lampholders that are approved for the application.

SA3.10 LED LENS, INTEGRAL – the optical element integral to an LED package that focuses or diffuses the light from the LED die(s). Optical assemblies secured to the LED package after package manufacture (such as during the assembly of an LED array) are not considered integral LED lenses.

SA3.11 POLARIZATION – observing the identification of the grounded supply conductor for electrical connection of certain components in order not to increase the risk of electric shock. (Not related to polarization of light.)

SA3.12 RETROFIT LUMINAIRE CONVERSION – the act of modifying, with additional parts, a luminaire that was already manufactured and in service in order to convert the luminaire to an LED light source, from an incandescent, fluorescent, or high intensity discharge light source. For this standard, direct replacement of an incandescent to LED lamp, without any electrical or mechanical changes, is not considered to be a luminaire conversion.

SA3.13 WORKING VOLTAGE – the highest voltage to which the insulation under consideration is or can be subjected when the equipment is operating at its rated voltage under conditions of normal use.

SA3.14 USE, GENERAL – a device that has been determined acceptable for direct installation in field applications in accordance with country-specific national electrical codes. A device complying with the requirements of this standard is considered to be for general use.

SA3.15 USE, SPECIAL – a device intended as a component of a luminaire or a unique application and subject to additional considerations when the final application is known. A device complying with the requirements of this standard and any additional requirements for the final application is considered to be for special use.

SA4 General Requirements

SA4.1 Requirements from Clause 4 apply.

SA5 Mechanical Construction

SA5.1 Enclosures

SA5.1.1 Requirements from Clause 5.1 apply and as amended below.

SA5.1.2 Lamp enclosures can be partially or entirely of glass. Glass is considered to be an inorganic material that can vary considerably in mechanical strength and resistance to cracking or breaking. Requirements in this supplement evaluate the material for lamp applications.

SA5.2 Openings

SA5.2.1 Requirements from Clause 5.2 apply and as amended below.

SA5.2.2 No openings are permitted for devices designated for wet locations.

SA5.3 Polymeric materials

SA5.3.1 Requirements from Clause 5.3 apply and as amended below.

SA5.3.2 The enclosing diffuser for an LED shall have a flammability rating as indicated in Table SA5.1. Different flammability ratings are assigned depending on the power available to the LED array and whether the LED driver has an isolated or direct connected output – see SA6.4.

Table SA5.1
LED lens and diffuser flammability ratings

Power Source	Class 2[a]	Isolated, non-Class 2[b]	Direct connected
Enclosure type needed	**None**	**Fire**	**Fire and electrical**
Integral LED Lens	Not defined	V1	V1
Other lenses and diffusers	Not defined	V0[c]	V0

[a]Power sources that also fall into this category include:

1) Limited Power Sources (LPS) compliant with UL 60950-1 or CSA C22.2 No. 60950-1,

2) Low Voltage, Limited Energy (LVLE) power sources compliant with UL 8750 or CSA C22.2 No. 250.13, and

3) Power sources not considered a risk of fire per 4.5.2.

[b]Power sources isolated from the mains that are not a risk of shock (per 4.5.1) also fall into this category.

[c]May be V1 or SC1 if the total volume of all diffusers is less than 2500 mm^3 (0.156 in^3). The flammability of small parts may alternatively be determined using UL 1694.

SA5.3.3 A polymeric sheet insulating material used between a live part and an accessible non-current-carrying metal part, such as a heat sink, shall comply with the applicable requirements of this clause and is considered basic insulation.

SA5.3.4 A conductive coating applied to a surface such as the inside surface of a cover, enclosure, reflector, or the like shall comply with the requirements for metallized parts in UL 746C.

Note: This does not apply to coatings applied to compartments or in locations where the electrical parts would represent neither a risk of fire nor a risk of electric shock if they were to come into contact with conductive debris under any condition of use.

SA5.3.5 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 UL 8750 or CSA C22.2 No. 250.13. Fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding are not subject to this test.

SA5.4 Weight and moment

SA5.4.1 Requirements from Clause 5.4 apply and as amended below.

SA5.4.2 Requirements from Clause 5.4 apply only to the lamps with the bases specified in Clause 5.4. The requirements do not apply to pin based lamps.

SA5.4.3 Unless there is provision to support additional mass (weight) so the device is not solely supported by general use lampholders, a device supported only by a pair of pin bases and holders (SA6.13) shall have a mass (weight) not more than:

a) 0.2 kg (7 oz or 0.44 lbs) when using a G5 base, or

b) 0.5 kg (17.6 oz or 1.1 lbs) when using a G13 base.

SA5.4.4 A GZ4 or G5.3 lampholder for low voltage lamps is not intended to support the mass (weight) of the lamp, so there is no specified value.

SA6 Electrical Construction

SA6.1 Lamp bases and lampholders

SA6.1.1 Requirements from Clause 6.1 apply and as amended below.

SA6.1.2 A lamp with other than an Edison screwbase shall have a base that complies the dimensions of a base described in ANSI C81.61.

SA6.1.3 Certain ANSI pin bases are designated for low voltage (< 30 V). See UL 1598 or CAN/CSA-C22.2 No. 250.0 for a listing of the low voltage bases.

SA6.1.4 For devices substituting for linear fluorescent lamps, Clause SA6.13, some contacts for the G5 or G13 lamp bases are not used for electrical connections and will only be intended for mechanical support of the lamp. Such contacts shall have no connection, and, if two unused contacts are in a single lamp base, the contacts shall not be connected (short-circuited) together or be connected (short-circuited) to any dead metal part of the lamp base. These devices shall be subjected to the Isolation of lamp pins, Clause SA8.20.

SA6.2 Current-carrying parts

SA6.2.1 Requirements from Clause 6.2 apply and as amended below.

SA6.2.2 For devices substituting for linear fluorescent lamps, Type C, the supply and the output (even if designated Class 2) wires connected to the LED driver shall be rated 300 V minimum, 90 °C minimum since separation of supply and output wires cannot be assured in installation.

SA6.3 Printed circuit boards

SA6.3.1 Requirements from Clause 6.3 apply and as amended below.

SA6.3.2 Printed circuit boards shall comply with UL 8750 or Annex E.

SA6.3.3 In the United States, flexible material printed wiring board constructions shall comply with UL 746F.

In Canada and Mexico, this requirement does not apply.

SA6.3.4 Circuit conductors can be placed on an alumina ceramic material similar to conventional printed wiring boards. The ceramic material is inorganic so there is no flame resistance rating assigned. The usage temperature limit of the ceramic material is much higher than the semiconductor junctions that will be mounted to the ceramic. The suitability of the bonding of the circuit conductors shall be determined by tests specified in UL 796. Foil circuit conductors shall be subjected to Bond Strength tests. Conductive paste conductors shall be subjected to the Conductive Paste Adhesion tests.

SA6.4 Ballasts and LED drivers

SA6.4.1 Requirements from Clause 6.4 apply and as amended below.

SA6.4.2 Clauses 6.4.1 – 6.4.4 pertain to fluorescent ballast construction and are not applicable to LED drivers. Clauses 6.4.5 – 6.4.7 are applicable to ballasts and LED drivers. Clause 6.4.8 is applicable to LED drivers.

SA6.4.3 Drivers for LEDs have outputs that are categorized as:

a) Class 2 circuit,

b) Isolated from the supply, but above the Class 2 circuit limits, or

c) Direct (Non-isolated, regardless of the supply voltage).

SA6.4.4 The construction of the LED driver circuitry shall comply with the appropriate requirements of UL 8750 or CSA C22.2 No. 250.13.

SA6.4.5 The LED driver shall comply with the component fault condition tests described in Clause SA8.22.

SA6.5 Power capacitors

SA6.5.1 Requirements from Clause 6.5 do not apply.

SA6.6 Spacing of electrical parts

SA6.6.1 Requirements from Clause 6.6 apply and as amended below.

SA6.6.2 Spacing at a lamp base for some ANSI configurations may be less than, and would supersede dimensions in the main text.

SA6.6.3 For devices for connection to a low voltage (< 30v) supply, UL 8750 or CSA C22.2 No. 250.13 requirements apply.

SA6.7 Accessibility of live parts

SA6.7.1 Requirements from Clause 6.7 apply.

SA6.8 Light source – fluorescent lamps

SA6.8.1 Requirements from Clause 6.7 apply.

SA6.9 Light source – light emitting diodes (LED)

SA6.9.1 Requirements from Clause 6.9 apply and as amended below.

SA6.9.2 LED light sources shall comply with UL 8750 or CSA C22.2 No. 250.13, as appropriate.

SA6.9.3 An LED array that is accessible, as determined by a lack of enclosure or as a result of mechanical testing of the lens or enclosure, shall not result in a risk of electric shock. Mechanical testing would include Drop Impact (8.8 or 8.15), Mold-stress Conditioning (8.9), and Humidity Conditioning (8.13) if rated damp or wet locations.

SA6.9.4 An LED array that is inaccessible, including results for mechanical testing as noted in Clause SA6.9.3, can be powered by a direct output type LED driver or an isolated type supply where the voltage would exceed electric shock hazard limits.

SA6.10 Light source – non-discharge lamps

SA6.10.1 Requirements from Clause 6.10 do not apply.

SA6.11 Grounding

SA6.11.1 Accessible non-current-carrying metal parts that could be energized from within and where the voltage is greater than 150 V shall be bonded to ground or be made inaccessible.

SA6.11.2 In lieu of grounding, devices may be constructed to a level of double insulation. Double insulated devices shall comply with UL 2097 or C22.2 No. 0.1. Devices shall be marked per Clause SA10.2.5.

SA6.11.3 A connector provided with a contact, or pole, for grounding shall arranged so the connection is the last connection to disconnect (first to make, last to break).

SA6.12 Polarization

SA6.12.1 A loss of polarization shall not introduce a risk of electric shock.

SA6.13 Devices substituting for linear fluorescent lamps

SA6.13.1 The requirements in this clause apply to LED devices that have the general appearance, length, and base types of a conventional fluorescent lamp. These devices have the physical dimensions of a lamp described in ANSI C78.81. The following constructions are considered by these requirements:

a) **Type A** – A device for general-use is intended for direct substitution of a fluorescent lamp and operating from the ballast that would be provided for the fluorescent lamp without additional modifications of the fluorescent lamp circuit.

In Canada, a Type A device is not allowed unless the ballast or driver in combination with the LED lamp is approved for the application.

b) **Type B** – A device for special-use intended for operation in luminaires that are either factory wired especially for the device or as a component for retrofit luminaire conversions involving modification of an existing luminaire, and the LED driver components are an integral part of the device.

c) **Type C** – A device for special-use intended for operation in luminaires that are either factory-wired especially for the device or as a component for retrofit luminaire conversions involving modification of an existing luminaire, and the LED driver components are remote from (or not an integral part of) the device.

Note: The above type designations are just for use in this supplement.

SA6.13.2 A device that substitutes for a linear fluorescent lamp shall comply with the Risk of Electric Shock – Relamping test, see Clause SA8.19. A Type C device powered from a remote LED driver and having a voltage of less than 30 volts need not be subject to this test.

SA6.13.3 Type A devices are not covered by these requirements.

SA6.13.4 A Type B or C device for special use as a component for retrofit luminaire conversions shall additionally comply with installation instructions described in Subject 1598C or CSA TIL B79.

SA6.13.5 Type B and C devices shall have the source of electrical supply applied either at one of the lamp bases or across the lamp at both lamp bases and the connections will be incompatible unless a special evaluation can show the device can be powered in either method. See SA8.21 for misapplication testing and SA10.2.3 for product marking.

SA6.13.6 Type C devices shall be for direct or alternating current operation and will be incompatible unless a special evaluation can show the device can be powered in either method. See Clause SA8.21 for misapplication testing and Clause SA10.2.3 for product marking.

SA6.13.7 Type C devices shall have a correlated marking regarding the lamp and remote LED driver the devices are intended to work with:

a) For the linear LED lamp operating with a remote LED driver, the lamp shall be marked in accordance with Table SA10.1, marking item 18C.

b) For the linear LED lamp operating with a remote LED driver, the LED driver shall be marked in accordance with Table SA10.1, marking item 18D.

SA6.13.8 A device interchangeable with linear fluorescent lamps shall have a base and overall length of one of the lamp types in Table SA6.1.

Table SA6.1
Common linear fluorescent lamp sizes[a]

Lamp diameter in 1/8 inch (mm) / length feet	Common wattage designation	Base Designation	Lamp Length - base face to face inch (mm)
T12 (38 mm)			
2	24	G13	23.2 (590)
3	30	G13	35.2 (895)
4	40	G13	47.2 (1199)
T8 (25 mm)			
2	17	G13	23.2 (590)
3	25	G13	35.2 (895)
4	32	G13	47.2 (1199)
5	40	G13	59 (1500)
T5 (16 mm)			
1	8	G5	11.3 (288)
1.5	15	G5	17.2 (437)
2	18	G5	21.6 (549)
T5HO (16 mm)			
2	24	G5	21.6 (549)
3	39	G5	33.4 (849)
4	54	G5	45.2 (1149)
5	80	G5	57 (1449)

Note: Lamp data rounded to 0.1 inch; source: Double Capped Fluorescent Lamps – Dimensional and Electrical Characteristics, ANSI C78.81.

Table SA6.1 Continued on Next Page

Table SA6.1 Continued

Lamp diameter in 1/8 inch (mm) / length feet	Common wattage designation	Base Designation	Lamp Length - base face to face inch (mm)
[a]For additional information, consult Double Capped Fluorescent Lamps – Dimensional and Electrical Characteristics, ANSI C78.81.			

SA6.13.9 A device interchangeable with linear fluorescent lamps shall comply with the mass (weight) requirements in Clause SA5.4.

SA6.13.10 A device described in Clause SA6.13 shall be marked, in accordance with Clauses SA10.1 – SA10.4, as appropriate.

SA6.14 Devices interchangeable with tungsten-halogen incandescent lamps

SA6.14.1 The requirements in this clause apply to LED devices that have the general appearance, bulb shape, and base types of a conventional T-H incandescent lamp. These devices have the physical dimensions of a lamp described in ANSI C78.24. The following constructions are considered by these requirements:

a) **Type A** – A device for general-use is intended for direct substitution of a TH incandescent lamp, consisting of a MR-11 or M-16 bulb shape and GZ4 or G5.3 base, and operating from a voltage supply less than 30 VAC or 42.4 VDC.

b) **Type B** – A device for general-use is intended for direct substitution of a TH incandescent lamp, consisting of a MR-11 or M-16 bulb shape and GU10 base, and operating from a 120 VAC.

Note: The above type designations are just for use in this supplement.

SA6.14.2 A Type A device for general use incorporates the LEDs and control circuitry to limit and or control the LED current. The device is intended to be powered from any LED driver having a suitable voltage and current.

SA6.14.3 A component LED lamp for only certain type of LED driver output (such as only Class 2) would not be considered for General-use but could be considered for Special-use applications.

SA6.14.4 A component LED lamp intended only for direct current shall comply with the component fault condition tests described in Clause SA8.22.

SA6.14.5 All devices of this type shall be marked in accordance with Clauses SA10.1 – SA10.4 as appropriate.

SA7 Environmental Locations

SA7.1 Requirements from Clause 7 apply.

SA8 Tests

SA8.1 General

SA8.1.1 Requirements from Clause 8.1 apply and as amended below.

SA8.1.2 The requirements in Clause SA8 also cover products described in the scope of this supplement.

SA8.1.3 Some LED lamps with an ANSI base other than bases E12, E17, E26, E39, or GU24 are intended for connection to a remote LED driver.

Table SA8.1
Test plan summary
(See Clause 8.1.4)

Test description	Reference	Number and description of samples
Electrical Tests		
Risk of electric shock – relamping	SA8.19	1 sample of each lamp.
Isolation of lamp pins	SA8.20	1 sample of each construction that can be one sample for a family of products.
Mechanical Tests		
Misapplication of lamp supply connections	SA8.21	Not more than four samples; less samples will depend on actual circuit.
LED lamp and driver abnormal condition tests	SA8.22	Number of samples depends on complexity of circuitry.
Note: This table is a summary of test samples typically needed. Actual number of samples may vary where agreeable to all parties concerned.		

SA8.2 Input measurements

SA8.2.1 Requirements from Clause 8.2 apply and as amended below.

SA8.2.2 It is permissible to operate an LED lamp in other than a base up position, for this test and the Temperature Test unless it is obvious a certain orientation is intended. See Clause SA8.5.2 for additional information.

SA8.2.3 LED lamps, with integrated control circuitry, and an ANSI base other than bases E12, E17, E26, E39, or GU10, or GU24 shall be tested with both AC and DC if the lamp rating specifies both current sources.

SA8.2.4 For low voltage bases, the device under test is to be powered from a source of AC or DC (as the device is rated) and at the rated voltage or current of the device.

SA8.3 Lamp starting and operating measurements

SA8.3.1 Requirements from Clause 8.3 do not apply.

SA8.4 Leakage-current test

SA8.4.1 Requirements from Clause 8.4 apply.

SA8.5 Temperature test

SA8.5.1 Requirements from Clause 8.5 apply and as amended below.

SA8.5.2 A device that is obviously intended only for horizontal mounting. For example, a device for street and parking lot luminaires, and having optical components only in a specific direction is permitted to be tested in a luminaire that fits the application. The luminaire shall represent the smallest volume, or by another method determined to be the luminaire that will result in the most onerous heating.

SA8.5.3 Devices substituting for linear fluorescent lamps shall be tested in both a horizontal and vertical orientation, except the device can be tested in only a horizontal orientation when the device is marked in accordance Table SA10.1, marking item 18B.

SA8.5.4 Since these requirements cover devices with varied bulb shapes and bases, special fabrication of test boxes beyond the ones described in the main body of this will be necessary. See SA9.5.2.

SA8.5.5 A device that is interchangeable with a linear fluorescent lamp shall be placed in a luminaire that completely encloses the lamp.

SA8.5.6 For a device substituting for linear fluorescent lamp, the device shall be subjected to the temperature test of Clause 8.5. The test fixture for testing the lamp shall be in accordance with Clause SA9.5.1. The temperature on components shall not exceed the limits described in Table 8.2.

SA8.6 Dielectric voltage-withstand test

SA8.6.1 Requirements from Clause 8.6 apply and as amended below.

SA8.6.2 For devices for connection to a low voltage (< 30 v) supply, the test potential shall be 500 v as described in the Dielectric Voltage Withstand Test in UL 8750 or CSA C22.2 No. 250.13.

SA8.6.3 For devices other than those in Clause SA8.6.2, the test potential shall be equal to 2V + 1000, where V is the maximum working voltage within the device.

SA8.7 Harmonic distortion test

SA8.7.1 Requirements from Clause 8.7 apply.

SA8.8 Drop impact test

SA8.8.1 Requirements from Clause 8.8 apply and as amended below.

SA8.8.2 All devices for dry, damp, or wet locations and with LEDs shall be subjected to the drop test described in Clause 8.8. The device is not powered during the test, but the assumption is that users might power the device after such an event to see if it is still functioning. Results to a glass or thermoplastic bulb or lens shall be considered as follows:

a) In the event the bulb or lens surrounding the LEDs does not break, the results can be considered acceptable.

b) In the event the bulb or lens surrounding the LEDs does break or crack, and

1) the device is rated for dry or damp locations, there shall be no breakage, cracks, holes, or openings of the glass or polymeric bulb resulting in risk of electric shock by accessing the live parts. Accessibility shall be determined using the test articulated probe in Figure 9.3, and

2) the device is rated for wet locations, the result is unacceptable.

SA8.9 Mold-stress relief conditioning

SA8.9.1 Requirements from Clause 8.9 apply.

SA8.10 Deflection test

SA8.10.1 Requirements from Clause 8.10 apply.

SA8.11 Strain relief test for lamp connectors

SA8.11.1 Requirements from Clause 8.11 do not apply.

SA8.12 Tests of dimmer circuits

SA8.12.1 Requirements from Clause 8.12 apply except as amended below.

SA8.12.2 For devices for connection to low voltage (< 30 V) supply, the requirements do not apply.

SA8.13 Humidity conditioning

SA8.13.1 Requirements from Clause 8.13 apply.

SA8.14 Water spray test

SA8.14.1 Requirements from Clause 8.14 apply.

SA8.15 Cold impact test

SA8.15.1 Requirements from Clause 8.15 apply.

SA8.16 Lamp fault conditions test

SA8.16.1 Requirements from Clause 8.16 do not apply.

SA8.17 End-of-lamp-life tests for fluorescent lamp adapters

SA8.17.1 Requirements from Clause 8.17 do not apply.

SA8.18 End-of-life test for integral, self-ballasted fluorescent lamps - one filament emission-mix-free test

SA8.18.1 Requirements from Clause 8.18 do not apply.

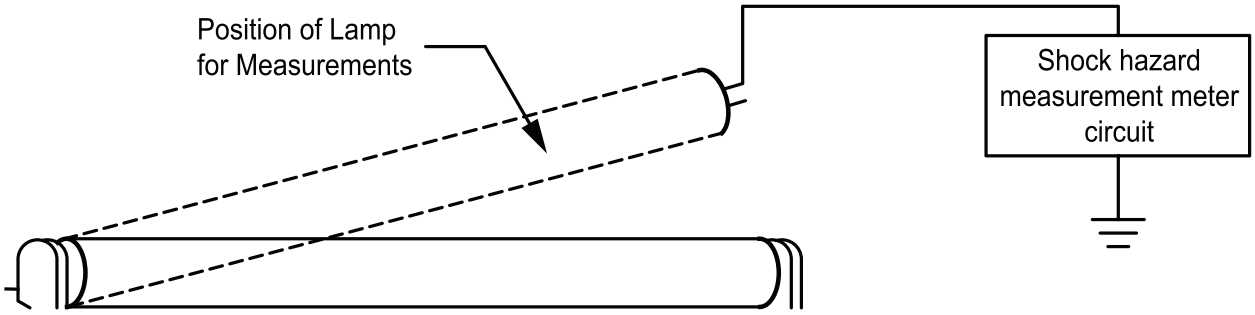
SA8.19 Risk of electric shock – relamping

SA8.19.1 As specified in Clause SA6.13.2, devices substituting for linear fluorescent lamps shall be evaluated for a possible risk of electric shock while installing, removing, or replacing the LED lamp device.

SA8.19.2 One end (lamp base) of the device under test shall be connected to its intended source of supply while the other end (lamp base) of the device shall be considered accessible and shall be connected to the shock hazard measurement meter circuit and, in turn, to earth ground as shown in Figure SA8.1. The current shall not exceed 5 M.I.U (7.07 peak M.I.U.).

SA8.19.3 The construction of the shock hazard measurement meter circuit, meter, and the explanation of M.I.U. measurement unit are described in UL 935.

Figure SA8.1
Risk of electric shock measurements



su0893

SA8.20 Isolation of lamp pins

SA8.20.1 For a device substituting for a linear fluorescent lamp, Type B, and with the intended supply connections only to one lamp base, as described in Clause SA6.1.4, the lamp shall withstand the following abnormal operation. The abnormal operation test shall be performed for 7 hours or until the lamp circuit opens. There shall be no visible signs of increased shock or fire hazard.

SA8.20.2 The LED lamp shall be operated with 600 V ac. applied to the pins of the opposite ends of the lamp for double ended LED lamps.

SA8.21 Misapplication of lamp supply connections

SA8.21.1 As described in Clauses SA6.13.5 and SA6.13.6, devices substituting for linear fluorescent lamps will have one or more intended, specific connections for electrical supply. Even when the lamp is marked for the intended connections, linear tubular lamps can have a lamp base inserted into an untended lampholder, or rotated clockwise or counterclockwise in the lampholder. Misapplication of the supply voltage can occur either during initial installation for a retrofit luminaire conversion or during a routine lamp replacement.

SA8.21.2 For testing of possible misapplications, various lamp positions and supply connections shall be tested. None of the combinations shall result in a fire or shock hazard condition. Opening of a protective component resulting in ceased operation would be an acceptable result.

SA8.21.3 For testing of possible misapplications, a grid of lamp connection combinations shall be prepared with the following, as applicable:

a) For the grid columns, the following electrical supply connections:

   1) 120 VAC, left lampholder

   2) 120 VAC, right lampholder

   3) 277 VAC, left lampholder

   4) 277 VAC, right lampholder

   5) In Canada, 347 VAC, left lampholder

   6) In Canada, 347 VAC, right lampholder

   7) 120 VAC, left lampholder to right lampholder

   8) 24 VDC, at positive at pin 1 of left lampholder

   9) 24 VDC, at positive at pin 1 of right lampholder

   10) 24 VDC, pin 1 of left lampholder to pin 1 of right lampholder

b) For the grid rows, the following lamp intended connections:

   1) 120 VAC rated, connections to one lamp base

   2) 277 VAC rated, connections to one lamp base

   3) 120 VAC rated, connections to across lamp to each lamp base

   4) 277 VAC rated, connections to across lamp to each lamp base

   5) In Canada, 347 VAC rated, connections to across lamp to each lamp base

   6) DC rated, positive and negative connected at one lamp base, and lamp rotated clockwise in lampholder to seat

7) DC rated, positive and negative connected at one lamp base, and lamp rotated counterclockwise in lampholder to seat

8) DC rated, positive and negative connected across lamp to each lamp base

9) As in case (7) above, but turned to opposite lampholders

The actual device under test will be just one of the grid rows. Depending upon particulars of the device under test, certain conditions can be determined as not applicable (such as testing 24 VDC products at 277 VAC) or additional conditions may be needed.

SA8.22 LED lamp and driver abnormal condition tests

SA8.22.1 During each test, accessible non-current-carrying metal parts, if provided, shall be connected to ground through a 3-A non-time delay fuse, and the device under test shall be draped with a double layer of cheesecloth conforming to the outline of the unit.

SA8.22.2 A risk of fire or electric shock shall be considered to exist with any of the following results:

a) Opening of the ground fuse,

b) Charring of the cheesecloth,

c) Emission of flame or molten material from the unit,

d) Exposure of live parts, or

e) Breakdown during the subsequent dielectric voltage withstand test (described in UL 8750 or CSA C22.2 No. 250.13)

SA8.22.3 Unless previously evaluated, an LED driver shall be subjected to the abnormal condition tests specified in UL 8750 or CSA C22.2 No. 250.13.

SA8.22.4 As a separate abnormal test condition, an LED lamp rated only for DC input shall be connected to an AC supply equal the rated voltage.

SA9 Test Apparatus

SA9.1 General

SA9.1.1 Requirements from Clause 9.1 apply.

SA9.2 Instrumentation

SA9.2.1 Requirements from Clause 9.2 apply.

SA9.3 Thermocouples

SA9.3.1 Requirements from Clause 9.3 apply.

SA9.4 Plywood test box material

SA9.4.1 Requirements from Clause 9.4 apply.

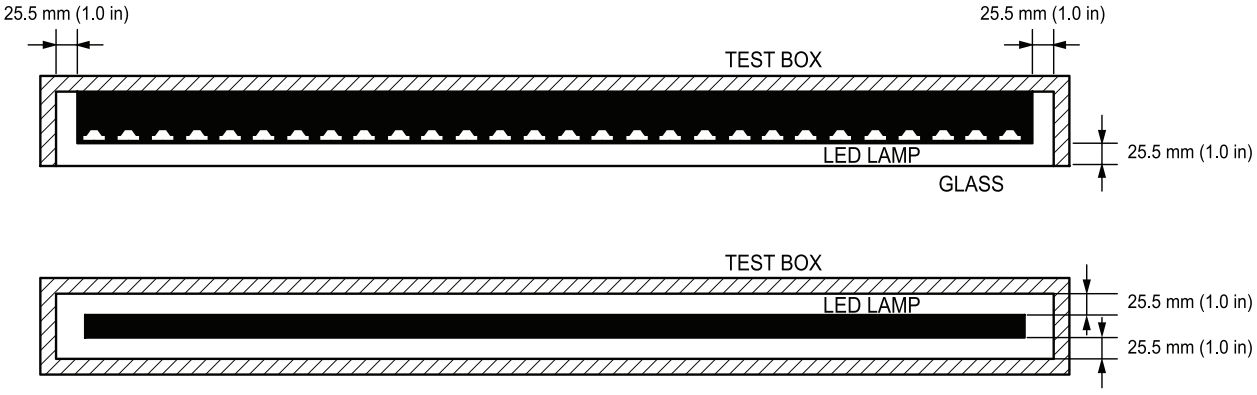
SA9.5 Temperature test boxes

SA9.5.1 Requirements from Clause 9.5 apply and as amended below.

SA9.5.2 The sides and top of the test fixture shall be constructed of 12.7 mm (1/2 in trade size) thick minimum grade C-D or better plywood. The bottom shall be closed off with a minimum 2.5 mm (0.1 in) thick piece of window glass of appropriate size.

SA9.5.3 The test box shall have a square cross-section. The dimensions of the sides of the square shall be equal to the overall LED lamp dimensions plus 25.5 mm (1.0 in). See Figure SA9.1 for details.

Figure SA9.1
Temperature test box



su0892a

SA9.6 Articulated probe

SA9.6.1 Requirements from Clause 9.6 apply.

SA9.7 Water spray apparatus

SA9.7.1 Requirements from Clause 9.7 apply.

SA9.8 Cheesecloth

SA9.8.1 Requirements from Clause 9.8 apply.

SA10 Device Markings

SA10.1 General

SA10.1.1 Requirements from Clause 10.1 apply.

SA10.2 Identifications and ratings

SA10.2.1 Requirements from Clause 10.2 apply and as amended below.

SA10.2.2 Regarding requirements describing the supply frequency, it would be one of the following and has the following meanings:

a) DC – meaning only direct current,

b) X – Y Hz – meaning “X” is a lower frequency limit or DC, and “Y” is an upper frequency limit.

SA10.2.3 In addition to the electrical rating specified in Clause SA10.2.2, for

a) Devices substituting for linear fluorescent lamps, Types B and C, connections for the source of electrical supply to the lamp pins shall be clearly marked on the lamp,

b) Devices substituting for linear fluorescent lamps, Type C, the connections for the low voltage supply to the lamp pins shall include polarity, if the supply is a direct current type.

c) Devices interchangeable with tungsten-halogen incandescent lamps, Type A, the connections for the low voltage supply to the lamp pins shall include polarity, if the supply is a direct current type.

SA10.2.4 For devices connecting G-type lamp base/holder, the electrical current rating shall not exceed 2 amperes.

SA10.2.5 Devices that are double insulated and comply with Clause SA6.11.2 shall be marked in accordance with Table SA10.1, Item 18A.

SA10.2.6 For devices interchangeable with tungsten-halogen incandescent lamps, Types A & B, the device shall be marked, “Only For Dry Locations” or “For Dry Locations,” or the equivalent marking for “damp,” but the full marking Table 10.1, items 9 or 10, shall be provided on packaging or instructions packed with the device.

Table SA10.1
List of required markings

Item	Marking	Text	Format	Text reference
	Product Markings			
18A	**DOUBLE INSULATION (or) DOUBLE INSULATED (or Symbol – a square within a square** (IEC Publication 417, Symbol 5172, as shown in Figure SA10.1)	Verbatim, symbol is a graphical element	S13L1	SA6.11.2, SA10.2.5
18B	**SUITABLE ONLY FOR HORIZONTAL OPERATION (or equivalent words describing the restricted positioning)**		S13L1	SA8.5.3
18C	**WARNING – RISK OF FIRE OR ELECTRIC SHOCK. NOT FOR DIRECT REPLACEMENT OF FLUORESCENT LAMPS. USE ONLY WITH (Manufacturer) (Catalog Number) LED DRIVER. SEE INSTRUCTIONS.**		S28-L1	SA6.13.7
18D	**REPLACE ONLY WITH (Manufacturer) (Catalog Number) LED Driver.**		S28-L1	SA6.13.7
	Package Markings			
28	**SUITABLE FOR OPEN LUMINAIRES (For devices that would replace TH lamps)**	Verbatim	S13L1	SA10.4.2
29	**This lamp employs light emitting diode technology and unlike tungsten-halogen lamps does not require a barrier. Lamp is suitable for open luminaires**		L2	SA10.4.2
30		Verbatim	S28-L2	SA10.4.3
31		Verbatim	S28-L2	SA10.4.4

Note: The text shown in the table does not represent the actual minimum size and typestyle required. Text in parentheses ( ) is descriptive or informative and not part of the actual marking notice.

Figure SA10.1
Double insulation symbol

SA10.3 Marking requirements in Mexico

SA10.3.1 Requirements from Clause 10.3 apply.

SA10.4 Instructions

SA10.4.1 Requirements from Clause 10.4 apply and as amended below.

SA10.4.2 For devices interchangeable with tungsten-halogen incandescent lamps, Types A & B:

a) The packaging shall be marked, “Suitable for open luminaires,” Table SA10.1, Item 28. Alternately, additional words can describe the lamp’s features, such as “This lamp employs light emitting diode technology and unlike tungsten-halogen lamps does not require a barrier. Lamp is suitable for open luminaires.” See Table SA10.1, Item 29.

b) It is permissible to use an alternate wording for Item 22 in Table 10.1 (not for use with emergency fixtures or emergency exit signs), “Not for emergency lighting.”

SA10.4.3 For devices substituting for linear fluorescent lamps, the packaging that would be seen in retail point-of-sale instances shall be marked in accordance with Item 30 in Table SA10.1.

SA10.4.4 For devices substituting for linear fluorescent lamps and rated for wet locations, the packaging that would be seen in retail point-of-sale instances shall be marked in accordance with Item 31 in Table SA10.1.

ANNEX A
(normative)
Standards for Components

A.1 The ANCE, CSA, and UL Standards listed below are used for evaluation of components and features of products covered by this standard. Components need only comply with the applicable component standard acceptable in the country where the product is to be used. This list is to be considered to refer to the latest edition and all amendments published to that edition.

Table A.1
UL, CSA, IEC, NMX, and NOM standards for components

Component type	UL Standard	CSA Standard	IEC Publication	NMX or NOM Standard
Ballast, fluorescent type	UL 935 Standard for Fluorescent-Lamp Ballasts	CAN/CSA-C22.2 No. 74-96 (R2010), Equipment for use with electric discharge lamps	IEC 61347-2-3, Lamp controlgear – Part 2-3: Particular requirements for AC-supplied electronic ballasts for fluorescent lamps; IEC 61347-2-4 Lamp controlgear – Part 2-4: Particular requirements for DC-supplied electronic ballasts for emergency lighting; IEC 61347-2-8, Lamp controlgear – Part 2-8: Particular requirements for ballasts for fluorescent lamps	NMX-J-198, Ballasts for fluorescent lamps
Ballasts, HID type	UL 1029 Standard for High-Intensity-Discharge Lamp Ballasts	CAN/CSA-C22.2 No. 74-96 (R2010), Equipment for use with electric discharge lamps	IEC 62035, Discharge lamps (excluding fluorescent lamps) – Safety specifications; IEC 61347-2-9, Lamp controlgear – Part 2-9: Particular requirements for ballasts and discharge lamps (excluding fluorescent lamps)	NOM-058-SCFI, Safety requirements for electrical discharge lamps; NMX-J-230 Electrical products mercury lamp ballasts methods of testing
Capacitors	UL 810 Standard for Capacitors	CAN/CSA-C22.2 No. 74-96 (R2010), Equipment for use with electric discharge lamps	IEC 61048, Capacitors for use in tubular fluorescent and other discharge lamp circuits	

Table A.1 Continued on Next Page

Table A.1 Continued

Component type	UL Standard	CSA Standard	IEC Publication	NMX or NOM Standard
Capacitors, across-the-line	UL 1414 Capacitors and Suppressors for Radio- and Television-Type Appliances	CAN/CSA-E60384-14-09, Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains		
Flexible cords and cable	UL 62 Flexible Cords and Cables	C22.2 No. 49-10, Flexible cords and cables	IEC 60227-1, Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V Part 1: General requirements	
Insulating material	UL 1446 Systems of Insulating Materials – General	CAN/CSA-C22.2 No. 0--10, General requirements	IEC 60085, Thermal evaluation and classification of electrical insulation	
Insulation systems	UL 2097 Reference Standard for Double Insulation Systems for Use in Electronic Equipment			
Lampholders	UL 496 Standard for Lampholders	CAN/CSA-C22.2 No. 43-08, Lampholders	IEC 60238, Edison screw lampholders; IEC 60400, Lampholders for tubular fluorescent lamps and starter holders	NMX-J-024-ANCE, Edison-base lampholders
Lampholders, bayonet base		CAN/CSA-C22.2 No. 43-08, Lampholders	IEC 61184, Bayonet lampholders	
Light Emitting Diode (LED) Equipment	UL 8750 Standard for Light Emitting Diode (LED) Equipment for Use In Lighting Products; Subject 1598C Outline of Investigation for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits	C22.2 No. 250.13, LED Equipment for Lighting Applications; CSA TIL B79, Requirements for Retrofitted Luminaires and LED Retrofit Kits		
Marking systems	UL 969 Standard for Marking and Labeling Systems	C22.2 No. 0.15-01 (R2006), Adhesive labels		

Table A.1 Continued on Next Page

Table A.1 Continued

Component type	UL Standard	CSA Standard	IEC Publication	NMX or NOM Standard
Plastic materials for parts in devices and appliances	UL 94 Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances	CAN/CSA-C22.2 No. 17-00 (R2004), Evaluation of properties of polymeric materials – General instruction		
Polymeric materials	UL 746A, UL 746B, UL 746C, UL 746D, UL 746E, and UL 746F Standards for Polymeric Materials; UL 1694 Standard for Tests for Flammability of Small Polymeric Component Materials	CAN/CSA-C22.2 No. 0.17-00 (R2009), Evaluation of properties of polymeric materials – General instruction		
Printed-wiring boards	UL 796 Standard for Printed-Wiring Boards	See Annex E of this standard	IEC 61191, Printed board assemblies	
Thermal protectors	UL 60691 Standard for Thermal-Links – Requirements and Application Guide	C22.2 No. 209-M85 (R2008), Thermal Cutoffs		
Transformers	UL 506 Standard for Specialty Transformers; UL 1310 Standard for Class 2 Power Units; UL 5085-3 Standard for Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers	CSA-C22.2 No. 66.1-06 (R2011), 66.2-06 (R2011) and 66.3-06 (R2011), Low voltage transformers; CAN/CSA-C22.2 No. 223-M91 (R2008), Power supplies with extra-low voltage class 2 outputs	IEC 61558-1, Safety of power transformers, power supply units, and similar products – Part 1: General requirements and tests	
Tubing, extruded insulated	UL 224 Extruded Insulating Tubing	CAN/CSA-C22.2 No. 198.1-06 (R2010), Extruded insulating tubing		
Wire connector terminals	UL 310 Standard for Electrical Quick-Connect Terminals	C22.2 No. 153-09, Electrical quick-connect terminals		

Table A.1 Continued on Next Page

Table A.1 Continued

Component type	UL Standard	CSA Standard	IEC Publication	NMX or NOM Standard
Wires and cables	UL 44 Standard for Thermoset-Insulated Wires and Cables; UL 62 Standard for Flexible Cords and Cables; UL 83 Standard for Thermoplastic-Insulated Wires and Cables; UL 758 Standard for Appliance Wiring Material; UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords	C22.2 No. 35-09, Extra low-voltage control circuit cable, low-energy control cables; C22.2 No. 49-10, Flexible Cords and Cables; C22.2 No. 127-99 (R2004), Equipment and lead wires; CSA C22.2 No. 210-05 (R2010), Appliance wiring material products		NMX-J-436, Conductors – Flexible cords for robust use and extra robust use up to 600 V – Specifications

ANNEX B (CAN)
(normative)
Markings – French Translations

Table B.1
Markings – French translation
(See Clauses 6.10.1, 6.10.2, 6.10.3, 7.1.1, 7.2.1, 7.3.1, 8.2.2, 8.5.3, 8.5.5, 8.5.6, 8.12.1, 8.14.1, 10.1.2 to 10.1.4, 10.2, 10.4, and F.1)

Item	Marking	Text	Format	Text reference
1	MANUFACTURER'S IDENTIFICATION IDENTIFICATION DU FABRICANT		S13L1	10.2.1 (a)
2	CATALOG or CAT NO. or SIMILAR DESIGNATION RÉFÉRENCE AU CATALOGUE ou RÉF. CAT. ou DÉSIGNATION SIMILAIRE		S13L1	10.2.1 (b)
3	DATE MARKING or CODE FORM MARQUAGE OU CODE DE LA DATE		S13L1	10.2.1 (c)
4	FACTORY IDENTIFICATION IDENTIFICATION DE L'USINE		S13L1	10.2.1 (d)
5	____ VOLTS ____ AMPS _____ WATTS ____ HERTZ or ____ V _____ A ____ W ____ Hz ___ VOLTS ____ AMPÈRES ____ WATTS ____ HERTZ ou ____ V _____ A ____ W ____ Hz		S13L1	10.2.2
6	USE WITH LAMP OF _____ WATTS UTILISER UNE AMPOULE DE ___ WATTS		S13L1	10.2.3
7	HIGH POWER FACTOR or HPF HAUT FACTEUR DE PUISSANCE OU HFP		S13L1	10.2.4
8	CAUTION ATTENTION	Verbatim	S20L1	6.10.1, 6.10.2 (a)
9	RISK OF ELECTRIC SHOCK – USE IN DRY LOCATION ONLY RISQUE DE CHOC ÉLECTRIQUE – UTILISER DANS UN EMPLACEMENT SEC UNIQUEMENT	Verbatim	S13L1	7.1.1
10	SUITABLE FOR DAMP LOCATIONS or RISK OF ELECTRIC SHOCK – DO NOT USE WHERE DIRECTLY EXPOSED TO WATER CONVIENT AUX EMPLACEMENTS HUMIDES ou RISQUE DE CHOC ÉLECTRIQUE – NE PAS UTILISER SI EXPOSÉ DIRECTEMENT À L'EAU	Verbatim	S13L1	7.2.1
11	SUITABLE FOR WET LOCATIONS CONVIENT AUX EMPLACEMENTS MOUILLÉS	Verbatim	S13L1	7.3.1
12	SUITABLE FOR WET LOCATIONS – MUST BE USED (words describing the restricted positioning) CONVIENT AUX EMPLACEMENTS MOUILLÉS – DOIT ÊTRE UTILISÉ	Verbatim	S13L1	7.3.1
13	DO NOT USE WITH DIMMERS NE PAS UTILISER AVEC DES GRADATEURS		S13L1	8.12.1
14	NOT FOR USE IN TOTALLY ENCLOSED LUMINAIRES NE CONVIENT PAS À DES LUMINAIRES TOTALEMENT FERMÉS		S13L1	8.5.6, 10.2.5

Table B.1 Continued on Next Page

Table B.1 Continued

Item	Marking	Text	Format	Text reference
15	**MAX ___WATTS TYPE _____ SHIELDED or MAX ____ W TYPE ___ SHIELDED**	Verbatim	S20L1	6.10.2
	___ WATTS MAX DE TYPE BLINDÉ ou ____ W MAX DE TYPE BLINDÉ			
16	**MAX ___WATTS TYPE _____or MAX ____ W TYPE ___**	Verbatim	S20L1	6.10.1
	___ WATTS MAX ou ____ W MAX			
17	**USE A LAMP MARKED: SUITABLE FOR USE IN OPEN DEVICES**	Verbatim	S13L1	6.10.3
	UTILISER UNE AMPOULE DONT LE MARQUAGE CONFIRME QU'ELLE CONVIENT AUX DISPOSITIFS OUVERTS			
	Instructions General			
	Instructions – généralités			
18	**"Hg" (In a circle)**	"Hg" verbatim, circle is a graphical element	S20L1	10.2.6
	«Hg» (dans un cercle)	«Hg» (litt.); le cercle est un élément graphique.		
19	**ADDED WEIGHT OF THE DEVICE MAY CAUSE INSTABILITY OF A FREE STANDING PORTABLE LUMINAIRE**		L2	10.4.1
	LE DISPOSITIF CONSTITUE UN POIDS SUPPLÉMENTAIRE CE QUI PEUT CAUSER L'INSTABILITÉ D'UN LUMINAIRE PORTATIF AUTONOME			
20	**USE ONLY WITH A PORTABLE TABLE LAMP THAT IS PROVIDED WITH A SHADE**		L2	10.4.1
	UTILISER UNIQUEMENT AVEC UNE LAMPE DE TABLE DOTÉE D'UN ABAT-JOUR			
21	**USE IN PORTABLE TABLE LAMPS IN WHICH THE DISTANCE FROM THE BOTTOM OF THE BASE TO THE TOP OF THE LAMPHOLDER DOES NOT EXCEED THREE (3) TIMES THE MINIMUM BASE DIAMETER**		L2	10.4.1, 10.4.3
	UTILISER AVEC UNE LAMPE DE TABLE POUR LAQUELLE LA DISTANCE ENTRE LA PARTIE INFÉRIEURE DU SOCLE ET LA PARTIE SUPÉRIEURE DE LA DOUILLE DE LAMPE N'EST PAS SUPÉRIEURE À 3 FOIS LE DIAMÈTRE MINIMAL DU SOCLE			
22	**THIS DEVICE IS NOT INTENDED FOR USE WITH EMERGENCY EXITS**		L2	1.5 and 10.4.4
	NE CONVIENT PAS AUX SORTIES DE SECOURS			
23	**SUITABLE FOR USE IN ENCLOSED LUMINAIRES**	Verbatim	S28L1	8.5.3 (e)
	CONVIENT AUX LUMINAIRES FERMÉS			
24	**MIN. LAMP COMPARTMENT DIMENSIONS _(L)_ x (W)_ mm**	Verbatim	S28L1	8.5.3 (e)
	DIMENSIONS MIN DU COMPARTIMENT ABRITANT L'AMPOULE ___ (long) X ___ (larg) mm			
25	**USE IN OPEN LUMINAIRE ONLY**	Verbatim	S28L1	8.5.3 (e)
	UTILISER UNIQUEMENT DANS UN LUMINAIRE OUVERT			

Table B.1 Continued on Next Page

Table B.1 Continued

Item	Marking	Text	Format	Text reference
26	**USE ONLY IN MODEL (model number) MANUFACTURED BY (manufacturer)**	Verbatim	S28L1	8.5.3 (e)
	UTILISER UNIQUEMENT AVEC LE MODÈLEFABRIQUÉ PAR			
27	**“Hg” (In a circle)**		S20L2	10.2.6
	«Hg» (dans un cercle)			
	“LAMP CONTAINS MERCURY”			
	«CETTE LAMPE CONTIENT DU MERCURE»			
	www.lamprecycle.org or www.epa.gov/bulbrecycling			
	www.lamprecycle.org ou www.epa.gov/bulbrecycling			
	(Optional) “Manage in Accord with Disposal Laws”			
	(facultatif) «Recycler selon la réglementation sur la gestion des matières résiduelles.»			
Note: The text shown in the table does not represent the actual minimum size and typestyle required.				

ANNEX C (MEX)
(normative)
Markings – Spanish Translations

Table C.1
Markings – Spanish translation
(See Clauses 6.10.1, 6.10.2, 6.10.3, 7.1.1, 7.2.1, 7.3.1, 8.2.2, 8.5.3, 8.5.5, 8.5.6, 8.12.1, 8.14.1, 10.1.2 to 10.1.4, 10.2, 10.4, and F.1)

Item	Marking/Marcado	Text	Format	Text reference
1	MANUFACTURER'S IDENTIFICATION NOMBRE O MARCA REGISTRADA DEL FABRICANTE O IMPORTADOR		S13L1	10.2.1 (a)
2	CATALOG or CAT NO. or SIMILAR DESIGNATION NÚMERO DE MODELO O CATÁLOGO O DESIGNACIÓN SIMILAR		S13L1	10.2.1 (b)
3	DATE MARKING or CODE FORM FECHA O CÓDIGO DE FABRICACIÓN		S13L1	10.2.1 (c)
4	FACTORY IDENTIFICATION IDENTIFICACIÓN DE LA PLANTA[a]		S13L1	10.2.1 (d)
5	____ VOLTS ____ AMPS _____ WATTS ____ HERTZ or ____ V _____ A ____ W ____ Hz[b]		S13L1	10.2.2
6	USE WITH LAMP OF _____ WATTS USAR CON LÁMPARA DE _____ W		S13L1	10.2.3
7	HIGH POWER FACTOR or HPF ALTO FACTOR DE POTENCIA o AFP[c]		S13L1	10.2.4
8	CAUTION PRECAUCIÓN	Verbatim	S20L1	6.10.1, 6.10.2 (a)
9	RISK OF ELECTRIC SHOCK – USE IN DRY LOCATION ONLY RIESGO DE CHOQUE ELÉCTRICO – USAR SOLO EN LUGARES SECOS	Verbatim	S13L1	7.1.1
10	SUITABLE FOR DAMP LOCATIONS or RISK OF ELECTRIC SHOCK – DO NOT USE WHERE DIRECTLY EXPOSED TO WATER ADECUADO PARA LUGARES HÚMEDOS O RIESGO DE CHOQUE ELÉCTRICO – NO USAR EN DONDE SE EXPONGA DIRECTAMENTE AL AGUA	Verbatim	S13L1	7.2.1
11	SUITABLE FOR WET LOCATIONS ADECUADO PARA LUGARES MOJADOS	Verbatim	S13L1	7.3.1
12	SUITABLE FOR WET LOCATIONS – MUST BE USED (words describing the restricted positioning) ADECUADO PARA LUGARES MOJADOS – DEBE USARSE (palabras que describan la posición restringida)	Verbatim	S13L1	7.3.1
13	DO NOT USE WITH DIMMERS NO USAR CON ATENUADORES DE LUZ		S13L1	8.12.1
14	NOT FOR USE IN TOTALLY ENCLOSED LUMINAIRES NO PARA USARSE EN LUMINARIOS TOTALMENTE CERRADOS		S13L1	8.5.6, 10.2.5
15	MAX ___WATTS TYPE _____ SHIELDED or ____ W MAX TIPO ___ BLINDADO[d]	Verbatim	S20L1	6.10.2

Table C.1 Continued on Next Page

Table C.1 Continued

Item	Marking/Marcado	Text	Format	Text reference
16	**MAX ___WATTS TYPE _____or**	Verbatim	S20L1	6.10.1
	____ W MAX TIPO ___[e]			
17	**USE A LAMP MARKED: SUITABLE FOR USE IN OPEN DEVICES**	Verbatim	S13L1	6.10.3
	USAR LÁMPARAS MARCADAS: ADECUADA PARA USO EN DISPOSITIVOS ABIERTOS			
18	**"Hg" (In a circle)**	"Hg" verbatim, circle is a graphical element	S20L1	10.2.6
	"Hg" (En un círculo)	"Hg" palabra por palabra, el círculo es un elemento gráfico		
19	**ADDED WEIGHT OF THE DEVICE MAY CAUSE INSTABILITY OF A FREE STANDING PORTABLE LUMINAIRE**		L2	10.4.1
	AÑADIR LA MASA DEL DISPOSITIVO PUEDE CAUSAR INESTABILIDAD DE UN LUMINARIO PORTÁTIL INDEPENDIENTE			
20	**USE ONLY WITH A PORTABLE TABLE LAMP THAT IS PROVIDED WITH A SHADE**		L2	10.4.1
	USAR SOLO CON UNA LÁMPARA DE MESA PORTÁTIL QHE ESTÉ PROVISTA CON PANTALLA			
21	**USE IN PORTABLE TABLE LAMPS IN WHICH THE DISTANCE FROM THE BOTTOM OF THE BASE TO THE TOP OF THE LAMPHOLDER DOES NOT EXCEED THREE (3) TIMES THE MINIMUM BASE DIAMETER**		L2	10.4.1, 10.4.3
	USAR EN LÁMPARAS DE MESA PORTÁTILES EN DONDE LA DISTANCIA DESDE LA PARTE INFERIOR DE LA BASE A LA PARTE SUPERIOR DEL PORTALÁMPARAS NO DEBE EXCEDER TRES VECES EL DIÁMETRO MÍNIMO DE LA BASE			
22	**THIS DEVICE IS NOT INTENDED FOR USE WITH EMERGENCY EXITS**		L2	1.5 and 10.4.4
	ESTE DISPOSITIVO NO SE DESTINA PARA USO EN SALIDAS DE EMERGENCIA			
23	**SUITABLE FOR USE IN ENCLOSED LUMINAIRES**	Verbatim	S28L1	8.5.3 (e)
	ADECUADO PARA USARSE EN LUMINARIOS CERRADOS			
24	**MIN. LAMP COMPARTMENT DIMENSIONS _(L)_ x _(W)_ mm**	Verbatim	S28L1	8.5.3 (e)
	DIMENSIONES MÍNIMAS DEL COMPARTIMIENTO DE LÁMPARA _(L)_ x _(A)_ mm[a]			
25	**USE IN OPEN LUMINAIRE ONLY**	Verbatim	S28L1	8.5.3 (e)
	USAR SOLO EN LUMINARIOS ABIERTOS			
26	**USE ONLY IN MODEL (model number) MANUFACTURED BY (manufacturer)**	Verbatim	S28L1	8.5.3 (e)
	USAR SOLO EN EL MODELO (número de modelo) FABRICADO POR (fabricante)			

Table C.1 Continued on Next Page

Table C.1 Continued

Item	Marking/Marcado	Text	Format	Text reference
27	**“Hg” (In a circle)**		S20L2	10.2.6
	“Hg” (En un círculo)			
	“LAMP CONTAINS MERCURY”			
	“LÁMPARA CONTIENE MERCURIO”			
	www.lamprecycle.org or www.epa.gov/bulbrecycling			
	(Optional) “Manage in Accord with Disposal Laws”			
	(Opcional) “Manejar de acuerdo con las leyes de eliminación de residuos”			

Note: The text shown in the table does not represent the actual minimum size and typestyle required.

[a] In Mexico, this marking does not apply.

[b] In Mexico, ___V ____ A ___W ___Hz is the only marking allowed.

[c] In Mexico, a device can be marked as “High Power Factor” or “HPF” if the power factor measured is 0.9 or greater.

[d] In Mexico, ___W MAX ___TIPO BLINDADO is the only marking allowed.

[e] In Mexico, ___W MAX ___TIPO is the only marking allowed.

ANNEX D
(normative)
Manufacturing and Production Tests

D.1 Dielectric Voltage-Withstand Test

D.1.1 Each device shall withstand without electrical breakdown, as a routine production-line test, the application of a potential between current-carrying parts of the supply circuit and accessible non-current-carrying metal as indicated in Table D.1.

Devices having no accessible metal parts, other than the screw shell of the device lamp base, need not be tested.

Table D.1
Production-line test conditions
(See Clauses D.1.1, D.1.2, and D.1.5)

Condition	Application time, seconds	Applied potential	
		40 – 70 Hz	DC
A	60	1240	1754
B	1	1488	2104

D.1.2 The production-line test shall be in accordance with either condition A or B of Table D.1.

D.1.3 The device may be in a heated or unheated condition for the test.

D.1.4 The test shall be conducted when the device is fully assembled. It is not intended that the product be unwired, modified, or disassembled for the test.

The test may be performed before final assembly if the test represents the completed product.

D.1.5 A device employing a solid-state component that is not relied upon to reduce a risk of electric shock and that can be damaged by the dielectric potential may be tested before the component is electrically connected provided that a random sampling of each day's production is tested at the potential specified in Table D.1. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state component damage while retaining representative dielectric stress of the circuit.

D.1.6 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic reject feature for any unacceptable unit.

D.1.7 If the output of the test equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

D.1.8 If the output of the test equipment transformer is 500 VA or larger, the test potential may be indicated:

a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,

b) By a selector switch marked to indicate the test potential, or

c) For equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential. When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

D.1.9 Test equipment other than that described by D.1.6 to D.1.8 may be used if found to accomplish the intended factory control.

D.1.10 Test records shall be retained for a period of at least six months, and shall include test quantity, test dates, catalog or model numbers, test results, and disposition of any non-complying products.

ANNEX E (CAN)
(normative)
Printed Circuit Boards

E.1 Special Terminology

The following definitions apply:

Insulation, basic – insulation to provide basic protection against electric shock.

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

Insulation, functional – insulation that is necessary only for the correct operation of the equipment.

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

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

E.2 General

E.2.1 A printed circuit board that is coated with a conformal coating or other coating shall be capable of withstanding the printed circuit board coatings test of Clause E.3. The coating shall be applied to the printed circuit board before installation of electrical components.

E.2.2 Printed circuit boards, conformal coating, and components shall comply with the vertical burning test of CAN/CSA-C22.2 No. 250.0 or the needle-flame test of CAN/CSA-C22.2 No. 250.0 for a flammability classification of at least V-2.

E.2.3 Components, such as IC packages, transistors, opto-isolators, and capacitors, shall be exempt from the flammability classification V-2 requirement of Clause E.2.2, if they are mounted on material having a flammability classification of at least V-1.

E.2.4 Spacings between uninsulated live parts of a circuit containing a solid-state component, such as a rectifier, resistor, capacitor, or transistor shall:

a) Be not less than the values shown in Table E.1,

b) Withstand the insulation resistance test of Clause E.3.4, or

c) Withstand the fault conditions test of Clause E.3.5.

Table E.1
Minimum spacings on printed circuit boards
(See Clauses E.2.4 and E.3.5.2)

To be classified as functional, basic, or supplementary insulation					To be classified as reinforced insulation			
Operating voltage	Uncoated		Conformal coated		Uncoated		Conformal coated	
rms	mm	(in)	mm	(in)	mm	(in)	mm	(in)
0 – 50	0.6	(0.024)	0.1	(0.004)	1.2	(0.048)	0.2	(0.008)
51 – 100	0.7	(0.028)	0.2	(0.008)	1.4	(0.055)	0.4	(0.016)
101 – 150	0.8	(0.032)	0.3	(0.012)	1.6	(0.063)	0.6	(0.024)
151 – 200	1.0	(0.039)	0.4	(0.016)	2.0	(0.079)	0.8	(0.032)
201 – 250	1.3	(0.051)	0.6	(0.024)	2.6	(0.102)	1.2	(0.048)
251 – 300	1.6	(0.063)	0.8	(0.032)	3.2	(0.126)	1.6	(0.063)
301 – 400	2.0	(0.079)	1.0	(0.039)	4.0	(0.157)	2.0	(0.079)
401 – 500	2.6	(0.102)	1.3	(0.051)	5.2	(0.205)	2.6	(0.102)
501 – 630	3.6	(0.142)	1.8	(0.071)	7.2	(0.238)	3.6	(0.142)
631 – 800	3.8	(0.150)	2.4	(0.094)	7.6	(0.299)	4.8	(0.189)
801 – 1000	4.0	(0.157)	2.8	(0.110)	8.0	(0.315)	5.6	(0.220)
1001 – 1250	4.2	(0.165)	3.4	(0.134)	8.4	(0.331)	6.8	(0.268)
1251 – 1600	4.6	(0.181)	4.1	(0.161)	9.2	0.362	8.2	(0.323)
1601 – 2000	5.0	(0.197)	5.0	(0.197)	10.0	(0.394)	10.0	(0.394)
2001 – 2500	6.3	(0.248)	6.3	(0.248)	12.6	(0.496)	12/6	(0.496)

E.3 Printed Circuit Board Coatings

E.3.1 Dielectric strength

E.3.1.1 A specimen shall be conditioned by flexing it 4 times so that the midpoint of the board is displaced from the line joining the two shortest edges of the board a distance equal to 5 percent of the length of the printed circuit board, to simulate conditions that can be expected under normal handling.

E.3.1.2 The following test voltages shall be applied for 1 min, without breakdown, between adjacent printed circuit conductors where the reduced spacings exist:

a) 500 V for a circuit operating at 50 V or less, and

b) 1000 V plus twice the working voltage for a circuit operating at more than 50 V.

E.3.1.3 The same specimen shall be conditioned by maintaining it for 96 h at 90 ±1 °C, and then shall be subjected to the test specified in Clause E.3.1.2.

E.3.1.4 The same specimen shall be conditioned at 23 ±1 °C and 96 ±2 % relative humidity for 96 h and then shall be subjected to the test specified in Clause E.3.1.2.

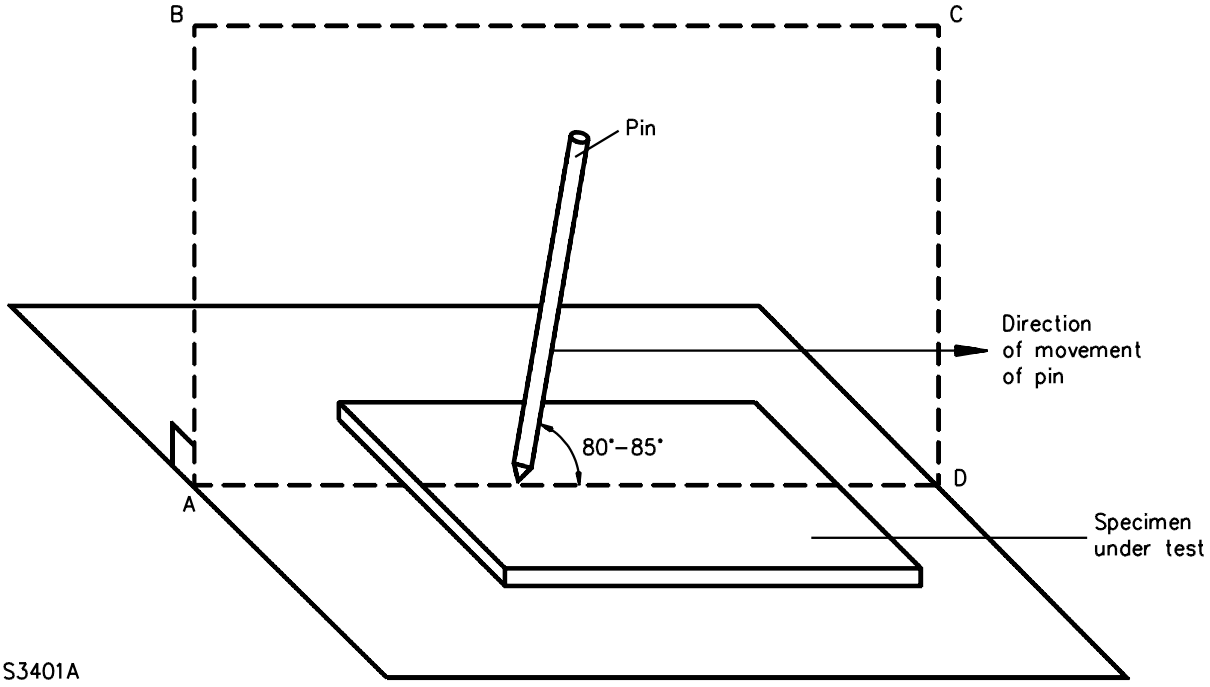
E.3.2 Adhesion

E.3.2.1 The same specimen used for the dielectric strength test shall be investigated for adhesion of the coating to the board by pressing a strip of pressure-sensitive celluloid tape 12.7 mm (0.5 in) wide and 50 mm (2 in) long firmly onto the surface of a conductor pattern, eliminating all air bubbles, and then removing it by manually gripping one end and rapidly pulling it off at an angle of approximately 90 degrees. There shall be no evidence of removal of the protective coating or the conductor pattern as shown by the pattern particles adhering to the tape. If slivers of metal adhere to the tape, it can be evidence of overheating and of unacceptable bond strength. The tape used for this test shall have an adhesion of 400 ±60 N/m (27 ±4 lb/ft), as determined by ASTM D 1000.

E.3.2.2 Using a specimen as described in Clause E.3.2.1 and the apparatus of Clause E.3.3, scratches shall be made across 5 pairs of conducting parts and the intervening separations at points where the separations will be subjected to the maximum potential gradient during the tests.

E.3.2.3 Scratches shall be made by drawing the pin along the surface in a plane perpendicular to the conductor edges at a speed of 20 ±5 mm/s (0.8 ±0.2 in/s), as shown in Figure E.1. The pin shall be so loaded that the force exerted along its axis is 10 ±0.5 N (2.25 ±0.1 lb) from the edge of the specimen.

Figure E.1
Abrasion resistance test apparatus for PCB conformal coatings
(See Clauses E.3.2.3 and E.3.3.1)



E.3.2.4 After this test, the coating layer shall neither have loosened nor have been pierced, and the specimen shall withstand a dielectric strength test between conductors, as specified in Clause E.3.1.

E.3.3 Abrasion resistance test apparatus

E.3.3.1 The test apparatus shall be as shown in Figure E.1. The pin shall be made of hardened steel. The end of the pin shall have the form of a cone with a top angle of 40 degrees, and its tip shall be rounded and polished, with a radius of 0.25 ±0.02 mm (0.010 ±0.001 in).

E.3.4 Insulation resistance test voltage

E.3.4.1 Functional, basic, supplementary, double, and reinforced insulation shall withstand the test voltages shown in Table E.2, in accordance with the dielectric voltage-withstand test of Clause E.3.1.

Table E.2
Insulation resistance test voltages
(See Clauses E.3.4.1)

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

E.3.5 Fault conditions

E.3.5.1 The printed circuit board with components shall be subjected to the fault conditions test of Clause E.3.5.2.

E.3.5.2 Each of the fault conditions of (a) and (b), as well as any other associated fault conditions that can arise as logical consequences, shall be applied in turn. Only one component at a time shall be subjected to any one fault condition:

a) Single-fault conditions representing the failure of components such as, but not limited to, semiconductor devices, capacitors, resistors, inductors, transformers, and protective devices. The failure mode shall be chosen to represent the manner in which the component is known to fail, and

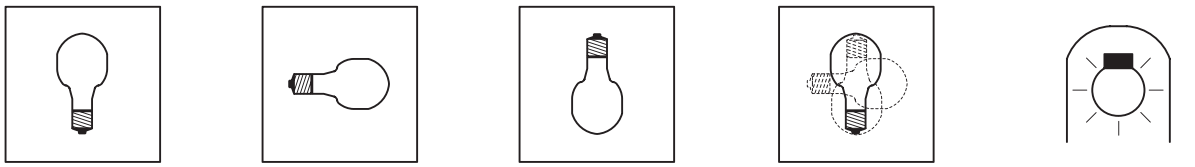
b) Opening or bridging points in the circuit where the spacing between the uninsulated live parts of a rectifier, resistor, capacitor, transistor, or other solid-state device is less than the values shown in Table E.1 and where such a fault condition can impair safety.

ANNEX F
(informative)
Pictograms

F.1 A pictogram used as a substitute for the corresponding text of Table 10.1 should provide a consistent representation of the information and is the subject of special investigation.

F.2 The recommended format of a pictogram including the text, as shown in Figure F.1, is a 19 mm (0.75 in) square for presentation.

Figure F.1
Examples of pictograms
(See Clauses 6.10.3, F.2, and F.4)



su0076

F.3 Current practice allows the pictogram of a lamp shade to be used without the border and text.

F.4 Figure F.1 includes a pictogram for an open luminaire.

ANNEX G
(informative)
Metric Conversion Information

Table G.1
Metric conversion multipliers

SI unit	SI symbol	Multiplier (SI x Mult = Imp)	Imperial unit	Imperial symbol
gram	g	0.0022	pound (weight)	lb
kilogram	kg	2.2046	pound (weight)	lb
millimetre	mm	0.0394	inch	in
metre	m	3.2808	foot	ft
square millimetre	mm^2	0.00155	square inch	in^2
square centimetre	cm^2	0.1550	square inch	in^2
cubic centimetre	cm^3	0.0610	cubic inch	in^3
square metre	m^2	10.7639	square foot	ft^2
cubic metre	m^3	35.3147	cubic foot	ft^3
newton	N	0.2248	pound-force (force)	lbf
newton metre	N•m	0.7376	pound-force foot (torque)	lbf•ft
newton metre	N•m	8.8512	pound-force inch (torque)	lbf•in
joule	J	0.7376	foot pound-force (energy)	ft•lbf
kilopascal	kPa	0.1450	pounds per square inch	psi
RSI (thermal resistance)	RSI m^2 • °C/W	5.6783	R (thermal resistance)	R ft^2 • °F • h/BTU
$gram/metre^2$	g/m^2	0.00328	$ounces/foot^2$	oz/ft^2
NOTE The values in this standard are specified in SI (metric) units, and the Imperial units given in parentheses are provided for information only.				