



UL 840

STANDARD FOR SAFETY

Insulation Coordination Including Clearances and
Creepage Distances for Electrical Equipment

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

Third Edition, Dated January 6, 2005

Summary of Topics

This revision to ANSI/UL 840 includes revised requirements for:

Surge Protective Devices Used in Electrical Equipment

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated August 12, 2011 and October 21, 2011.

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1

UL 840

Standard for Insulation Coordination Including Clearances and Creepage

Distances for Electrical Equipment

First Edition – December, 1984

Second Edition – May, 1993

Third Edition

January 6, 2005

This ANSI/UL Standard for Safety consists of the Third Edition including revisions through May 4, 2012.

The most recent designation of ANSI/UL 840 as an American National Standard (ANSI) occurred on May 3, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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

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CONTENTS

INTRODUCTION

1 Scope	4
2 Glossary	5
3 Units of Measurement	.6A
4 Undated References	.6A
5 Components	.6A
6 Insulation Coordination	.7

CONSTRUCTION

7 Clearance A (Equivalency)	9
8 Clearance B (Controlled Overvoltage)	10
9 Creepage Distances	12
10 Measurement of Clearance and Creepage Distances	15
11 Use of Coatings to Achieve Insulation Coordination	23

PERFORMANCE

12 Switching Test	23
13 Recurring Peak Voltage Determination	23
14 Dielectric Voltage-Withstand Tests	24
14.1 Testing in lieu of measuring clearances	24
14.2 Testing for controlled overvoltage	25
15 Printed Wiring Board Coating Performance Test	25
15.1 General	25
15.2 Dielectric voltage-withstand test	27
15.3 Environmental cycling test	28
15.4 Humidity conditioning test	28
15.5 Thermal conditioning test	28
15.6 Coating adhesion	30
15.7 Insulation resistance between conductors	30
15.8 Impulse withstand voltage	31
15.9 Resistance to soldering heat	31
15.10 Flammability	31
15.11 Comparative tracking index (CTI)	31

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INTRODUCTION

1 Scope

1.1 These requirements cover an alternate approach to specifying through air and over surface spacings for electrical equipment through the use of the principles of insulation coordination.

1.2 The complete principles of insulation coordination involve the consideration of the combination of clearances, creepage distances, and the properties of solid insulation used to constitute the insulation system. The empirical data gathered thus far has been used to develop the requirements for clearances and creepage distances as presented in this standard. The data needed to develop the evaluation procedure for solid insulation is still being gathered. When available, this evaluation procedure will be added to this standard and is not expected to affect the requirements for clearances and creepage distances.

1.3 These requirements may be used as an alternate to required spacing levels specified in end-product standards. The end product standard spacing requirements may be based on use and systems where overvoltages are not controlled, or if controlled, the level of control is unknown.

1.4 These alternate requirements are intended to be applied to a particular product category if the standard covering the product category specifically references UL 840 or any of the requirements therein.

1.5 Users of these requirements may need to specify the overvoltage levels and the methods of control which will be utilized, and establish the pollution degree to which the product insulation system will be expected to be subjected.

1.6 It is not intended that the test values in this standard be employed for production line testing. However, users of these requirements will need to establish a means to ensure that production controls applied to permit the spacing reduction remain in effect during the manufacture of the product. This could include sample testing or physical measurements or another equivalent means.

1.7 Users of these requirements will additionally need to ensure that influencing factors not addressed in this standard, such as mechanical movement, field placement of conductive material, and product damage, will not affect the system for insulation coordination. Examples are the deformation of the enclosure, movement of the fittings for conduit or armored cable, or the improper installation of field wiring. Clearances and creepage distances at those locations must be verified for compliance by physical measurement in accordance with Section 10, Measurement of Clearance and Creepage Distances.

2 Glossary

2.1 For the purpose of this standard, the following definitions apply.

2.2 CLEARANCES – Through air spacing.

2.2A COMBINATION WAVEFORM – A surge delivered by a generator which has the inherent capability of applying a 1.2/50 μ s voltage wave across an open circuit, and delivering an 8/20 μ s current wave into a short circuit. Also called a combination surge.

2.2A added May 4, 2012

2.3 CREEPAGE DISTANCES (CREEPAGES) – Over surface spacings.

2.4 FUNCTIONAL OVERVOLTAGE – Deliberately imposed transient overvoltages necessary for the function of a device.

2.5 GENERAL ENVIRONMENT – The overall area or space in which the equipment is located. Commonly referred to as ambient conditions.

2.6 IMPULSE WITHSTAND VOLTAGE – The highest peak value of impulse voltages, of prescribed form and polarity, that does not cause breakdown under specified conditions of test.

2.7 INSULATION COORDINATION – The correlation of insulating characteristics of electrical equipment:

a) With expected overvoltages and characteristics of overvoltage protective devices (a key consideration for clearances); and

b) With the expected micro-environment and pollution protective means (key considerations for creepage distances).

2.8 LEAKAGE CURRENT – The current that can be measured as flowing between test points during a dielectric voltage-withstand test.

2.9 LIGHTNING OVERVOLTAGE – The transient overvoltage at a given location on a system due to a specific lightning discharge.

2.10 MICRO-ENVIRONMENT – The conditions that immediately surround the clearance or creepage distance under consideration. The micro-environment of the creepage distance or clearance and not the general environment of the equipment determines the effect on the insulation. The micro-environment might be less severe or more severe than the general environment that the equipment is in. It includes all factors influencing the insulation, such as climatic, electromagnetic, and generation of pollution.

2.10A NOMINAL DISCHARGE CURRENT (I_n) – Peak value of the current, selected by the manufacturer, through the SPD having a current waveshape of 8/20 where the SPD remains functional after 15 surges.

2.10A added May 4, 2012

2.11 OPERATING VOLTAGE – The voltage across two points occurring due to normal operation of the product when controls are set in any position.

2.12 OVERVOLTAGE CATEGORY – Grouping of products based on typical installed location with respect to overvoltage protection and available energy. See note c of Table 8.1.

2.13 POLLUTION – Any addition of contaminants, solid, liquid or gaseous (ionized gases), and moisture that may produce a reduction of dielectric strength or surface resistivity.

2.14 POLLUTION DEGREE – The level of pollution present at the location on or in a product where the clearance and creepage distance measurement is made, and can be controlled by design of the product. For example, enclosures can be used to achieve pollution degree 3, heaters within enclosures can help achieve pollution degree 2, and encapsulation can be used to achieve pollution degree 1. See 9.3.

2.15 RATED VOLTAGE – The voltage employed for test purposes by the end-product standard.

2.16 RECURRING PEAK VOLTAGE – Deliberately or naturally imposed transient overvoltage that exceeds the steady state voltage, and is caused by operating a control or adjustable component. The voltage level will be consistent for the same operation under the same conditions. Insulating materials can be degraded by ozone generated by partial discharges due to recurring peak voltages.

2.16A SURGE PROTECTIVE DEVICE (SPD) TYPE DESIGNATIONS – SPD Type designations are as follows:

TYPE 1 – Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device.

TYPE 2 – Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device - including SPDs located at the branch panel.

TYPE 3 – Point of utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, for example cord connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance of 10 meters (30 feet) is exclusive of conductors provided with or used to attach SPDs.

TYPE 4 COMPONENT ASSEMBLIES – Component assembly consisting of one or more Type 5 components together with a disconnect (integral or external) or a means of complying with the limited current tests.

TYPE 1, 2, 3 COMPONENT ASSEMBLIES – Consists of a Type 4 component assembly with internal or external short circuit protection.

TYPE 5 – Discrete component surge suppressors, such as MOVs that may be mounted on a PWB, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

2.16A added May 4, 2012

2.17 SWITCHING OVERVOLTAGE – The transient overvoltage at a given location on a system due to a specific switching operation or fault.

2.18 SYSTEM VOLTAGE – The rated supply or line voltage to which the product will be connected.

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2.19 TRANSIENT OVERVOLTAGE – Nonperiodic voltages that may be caused by switching, lightning, or function of a device.

3 Units of Measurement

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

4 Undated References

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

5 Components

5.1 Except as indicated in 5.2, a component of a product covered by this standard shall comply with the requirements for that component.

5.2 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.

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

5.4 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.

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6 Insulation Coordination

6.1 This standard uses the principles of insulation coordination to provide requirements for clearances and creepage distances for electrical equipment. A design consideration is to prevent undesirable breakdowns in some areas due to their disruptive nature and potential for risk of fire and electric shock. Insulation coordination also requires the awareness of the insulating material properties so that design of the product can utilize the reduced spacing concept.

6.2 Insulation coordination, as evaluated and implemented through the use of this standard, can be achieved in a multiconcept process.

a) The first concept detailed in Section 7, Clearance A (Equivalency), of this standard is an alternative approach to measuring spacings currently defined in various product standards. This approach uses a dielectric voltage-withstand test impulse to evaluate equivalence of designed spacings to the predefined dimension. An actual reduction in spacings can be permitted through a refinement in manufacturing techniques while maintaining equivalent breakdown levels.

b) The second concept detailed in Section 8, Clearance B (Controlled Overvoltage), of this standard, a step in the insulation coordination process, is the selection of clearances based on the level of overvoltage protection and pollution degree.

c) The third concept detailed in Section 9, Creepage Distances, of this standard is the selection of an appropriate set of creepage distances based on operating voltage, pollution degree and material tracking characteristics.

d) The last concept, currently anticipated though not described in detail in this standard, is the choice of solid insulation to coordinate with the clearances and creepage distances chosen. The solid insulation must have suitable tracking properties for creepage considerations and it must have a breakdown level exceeding that of the controlled overvoltage level provided.

6.3 The database upon which these requirements are based is contained in the International Electrotechnical Commission (IEC) Publications for Insulation Coordination Within Low Voltage Systems Including Clearances and Creepage Distances for Equipment, 664, and the Supplement, IEC Publication 664A.

6.4 The data contained in these IEC documents relate the ability of clearances to withstand overvoltages based on the characteristics of the electrical field. For a specified overvoltage, an inhomogeneous field condition of two electrodes, which is represented by a point and a plane, requires the largest clearance. As the condition of the electric field is improved by control of electrode shape, the clearance required to withstand the overvoltage decreases. The limit for this decrease in clearance is that of the homogenous field which is represented by two parallel planes. Using this data it is possible to evaluate clearances by their ability to withstand overvoltages. It should be recognized that the use of this technique requires the regular rechecking of the ability of the clearance to withstand the prescribed overvoltage because of possible variations in the production process, the wearing of tools, or other factors that might influence the clearance or electrical field condition. The database may also be used to specify, for a given overvoltage, the inhomogeneous field clearance, and the continued provision of this clearance may be made by measurements of the clearance.