



UL 353

**Underwriters Laboratories Inc.  
Standard for Safety**

Limit Controls

*ULNORM.COM : Click to view the full PDF of UL 353 2011*



[ULNORM.COM](http://ULNORM.COM) : Click to view the full PDF of UL 353 2017

UL Standard for Safety for Limit Controls, UL 353

Fifth Edition, Dated September 23, 1994

### **Summary of Topics**

***These revisions to UL 353 are being issued to revise the requirements covering surge protective devices in Section 3A.***

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 new/revised requirements are substantially in accordance with Proposal(s) on this subject dated August 26, 2011.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

No Text on This Page

[ULNORM.COM](http://ULNORM.COM) : Click to view the full PDF of UL 353 2011

**SEPTEMBER 23, 1994**

(Title Page Reprinted: November 8, 2011)

1

**UL 353**

**Standard for Limit Controls**

First Edition – July, 1970

Second Edition – August, 1971

Third Edition – December, 1974

Fourth Edition – March, 1989

**Fifth Edition**

**September 23, 1994**

This UL Standard for Safety consists of the Fifth Edition including revisions through November 8, 2011.

The Department of Defense (DoD) has adopted UL 353 on January 27, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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>.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

**COPYRIGHT © 2011 UNDERWRITERS LABORATORIES INC.**

ULNORM.COM. Click to view the full PDF of UL 353 2011

No Text on This Page

[ULNORM.COM](http://ULNORM.COM) : Click to view the full PDF of UL 353 2011

## CONTENTS

### INTRODUCTION

1 Scope .....	5
2 General .....	6
2.1 Units of measurement .....	6
2.2 Components .....	6
3 Glossary .....	6

### CONSTRUCTION

3A Components .....	6B
3A.1 General .....	6B
3A.2 Attachment plugs, receptacles, connectors, and terminals .....	7
3A.3 Batteries and battery chargers .....	8
3A.4 Electrical boxes and raceways .....	8A
3A.5 Capacitors and filters .....	8A
3A.5A Surge Protective Devices .....	8A
3A.6 Gaskets and seals .....	8D
3A.7 Insulation systems .....	8D
3A.8 Overcurrent protection .....	8D
3A.9 Marking and labeling systems .....	8E
3A.10 Power supplies .....	8E
3A.11 Printed wiring boards .....	8E
3A.12 Semiconductors .....	8F
3A.13 Supplemental insulation, insulating bushings, and assembly aids .....	8F
3A.14 Valves (electrically operated) and solenoids .....	8F
4 General .....	8G
4A Safety Related Software .....	9
4B Electronic Controls .....	9
5 Materials .....	10
6 Frame and Enclosure .....	10
6.1 General .....	10
6.1A Polymeric materials and enclosures .....	13
6.2 Accessibility of live parts .....	13
6.3 Covers and doors .....	15
6.4 Openings .....	16
7 Corrosion Protection .....	17
8 Insulating Material .....	18
9 Field Wiring Connections .....	19
9.1 General .....	19
9.2 Terminals .....	20A
9.3 Wiring space .....	22A
10 Current-Carrying Parts .....	22A
11 Internal Wiring .....	22A
12 Grounding .....	23
13 Protection of Users and Service Personnel .....	27
14 Transformers .....	29
15 Fuseholders .....	30
16 Switches .....	30
17 Coil Windings and Film-Coated Wire (Magnet Wire) .....	30A

18	Spacings	30A
18.1	General	30A
18.2	High-voltage circuits	30A
18.3	Low-voltage circuits	32
19	Alternate Spacings – Clearances and Creepage Distances	33
20	Separation of Circuits	33
20.1	General	33
20.2	Barriers	34
21	Calibration Means	34
22	Mounting	34
23	Operating Mechanism	35
24	Adjustment and Stops	35
25	Reset Mechanism	35

## PERFORMANCE

26	General Tests	36
27	Input Test	37
28	Temperature Test	37
28.1	General	37
28.2	Temperature test of temperature control for air or other gas	40
28.3	Temperature test of temperature control for liquids	41
28.4	Temperature test of steam pressure or boiler water-level limit control	41
28.5	Temperature test of stack-mounted control	42
29	Operation Tests	44
29.1	General	44
29.2	Test of immersion-type temperature-operated control	46
29.3	Test of surface-mounted temperature-operated control for hot-water heating systems	46
29.4	Test of pressure-operated control	46
29.5	Test of electromagnet	47
30	Overload Test	47
31	Endurance Test	50
31A	Failure Mode Effect Analysis (FMEA) Procedures	52
31B	Mains Borne Perturbations, Magnetic and Electromagnetic Disturbances	52A
31B.1	General	52A
31B.2	Voltage dips and interruptions	52B
31B.3	Ramp voltage tests	52C
31B.4	Voltage/current surge tests	52C
31B.5	Ring wave test	52D
31B.6	Electrostatic discharge tests	52D
31B.7	Radiated electromagnetic field test	52E
31C	Thermal Cycling Test for Electronic Devices	52E
32	Dielectric Voltage-Withstand Test	52F
33	Volt-Ampere Capacity Test	53
34	Burnout Test	53
35	Short Circuit Test	54
36	Leakage Test	55
37	Strength of Parts Test	56
38	Parts Containing Liquid Metal	56A
39	10-Day Moist Ammonia Air Stress Cracking Test	57
40	Push-In Terminals Test	58
40.1	Pullout test	58
40.2	Temperature test	58

41 Volume Change Test .....59

ULNORM.COM : Click to view the full PDF of UL 353 2011

No Text on This Page

[ULNORM.COM](http://ULNORM.COM) : Click to view the full PDF of UL 353 2011

42 Weight Loss Test .....	.60
---------------------------	-----

## MANUFACTURING AND PRODUCTION TESTS

43 General .....	.60
------------------	-----

## RATING

44 Rating .....	.60
-----------------	-----

## MARKING

45 General Marking .....	.61
46 Cautionary Markings .....	.63
47 Markings (Visibility and Permanence) .....	.63
47.1 General .....	.63
47.2 Oven-aging test .....	.64
47.3 Immersion test .....	.64
47.4 Standard-atmosphere test .....	.64
47.5 Unusual-condition exposure test .....	.65

## INSTRUCTIONS

48 Installation Instructions .....	.65
------------------------------------	-----

## SUPPLEMENT SA - SOFTWARE IN PROGRAMMABLE COMPONENTS

SA1 Application of Requirements .....	.SA1
SA2 General .....	.SA1
1A General .....	.SA1
SA3 Qualification of Design, Implementation, and Verification Tools .....	.SA1
SA4 Measures to Address Microelectronic Hardware Failure Modes .....	.SA2
SA5 Documentation .....	.SA2
SA6 Identification .....	.SA2

ULNORM.COM: Click to view the full PDF of UL 353 2011

This page intentionally left blank.

[ULNORM.COM](http://ULNORM.COM) : Click to view the full PDF of UL 353 2011

## INTRODUCTION

### 1 Scope

1.1 These requirements cover limit controls, furnace fan controls, and other interlocks which are essentially switches responding to changes in liquid level, pressure, or temperature. Although not limited to such specific applications, these safety controls include those intended primarily to safeguard heating appliances, heating systems, processing systems, and air-conditioning and ventilating systems.

1.2 These requirements do not cover thermal protectors for motors and fluorescent-lamp ballasts.

1.3 These controls are for use in ordinary locations. Requirements for the installation and use of limit controls are included in Standards of the National Fire Protection Association, such as those for Installation of:

Air-Conditioning and Ventilating Systems, NFPA 90A-1993,

Warm-Air Heating and Air-Conditioning Systems, NFPA 90B-1993,

Oil-Burning Equipment, NFPA 31, ANSI Z95.1-1993,

National Fuel Gas Code, NFPA 54-1990,

Ovens and Furnaces, NFPA 86-1990, and

Prevention of Furnace Explosions in Fuel Oil and Natural Gas-Fired Watertube Boiler Furnaces With One Burner, NFPA 85C-1991.

1.4 These requirements cover equipment rated not more than 600 volts and intended for installation in accordance with the requirements of the National Electrical Code, ANSI/NFPA 70.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.5 revised April 30, 2001

## 2 General

### 2.1 Units of measurement

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

2.1.1 revised April 30, 2001

### 2.2 Components

2.2 deleted April 22, 2011

2.2.1 *deleted April 22, 2011.*

2.2.2 *deleted April 22, 2011.*

2.2.3 *deleted April 22, 2011.*

2.2.4 *deleted April 22, 2011.*

## 3 Glossary

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

3.1A COMPONENT – A device or fabricated part of the control covered by the scope of a safety standard dedicated to the purpose. When incorporated in a control, equipment otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as thermoplastic or copper, are not considered components.

3.1A added April 22, 2011

3.2 CONTROL, FAN – An automatic control responsive to changes in temperature, intended to control the operation of the fan on forced air appliances.

3.3 CONTROL, LIMIT – An automatic safety control responsive to changes in liquid level, pressure, or temperature and normally set beyond the operating range for limiting the operation of the controlled equipment.

3.4 CONTROL, OPERATING – A control, other than a safety control or interlock to start or regulate appliances according to load demand and to stop or regulate output on satisfaction of demand or upon reaching normal temperature or pressure in the appliances. Operating controls may also actuate auxiliary equipment.

3.5 CONTROL, SAFETY or PROTECTIVE – Automatic controls and interlocks (including relays, switches and other auxiliary equipment used in conjunction therewith to form a safety-control system) which are intended to prevent unsafe operation of the controlled equipment.

3.5 revised April 22, 2011

3.5A CONTROL, WATER HEATER REGULATING – An automatic control responsive to changes in temperature, intended to regulate the operation of the water heater and provides protective function.

3.5A added April 22, 2011

3.5B CONTROL, WATER HEATER LIMIT – A manual type control responsive to changes in temperature, intended to provide protective function of the water heater.

3.5B added April 22, 2011

### 3.6 ELECTRICAL CIRCUITS:

a) High-Voltage Circuit – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage or an isolated limited secondary circuit.

b) Low-Voltage Circuit – A circuit involving a potential of not more than 30 volts alternating current (ac) [42.4 volts peak or direct current (dc)] and supplied by a primary battery or by a standard Class 2 transformer, or by a combination of transformer and fixed impedance which, as a unit, complies with all the performance requirements for a Class 2 transformer. (A circuit derived from a source of supply classified as a high-voltage circuit, using resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage nor an isolated limited secondary circuit.)

c) Safety-Control Circuit – A circuit involving one or more safety controls.

d) Isolated Limited Secondary Circuit – A circuit of limited energy derived from an isolated secondary winding of a transformer having a maximum capacity of 100 volt-amperes and open-circuit secondary voltage not exceeding 1000 volts.

e) Intrinsically Safe Circuit – A circuit involving equipment and wiring which is incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. Abnormal conditions include accidental damage to any part of the equipment or wiring, insulation or other failure of electrical components, application of overvoltage, adjustment and maintenance operations, and other similar conditions.

3.7 INTERLOCK – A control to prove the physical state of a required condition, and to furnish that proof to the primary safety-control circuit. A limit control is a type of interlock.

3.8 REPEATABILITY – The ability of a control or interlock to maintain a constant set point characteristic.

3.9 SET POINT – A predetermined value to which a control or interlock is adjusted and at which it performs its intended function.

3.10 SUPERVISE – To sense a condition requiring attention and initiate corrective action if necessary.

3.11 TOOLS, SPECIAL – Those tools that are not generally available on the open retail market.

3.12 VENT LIMITING MEANS – A means which limits the flow of fluid from an atmospheric diaphragm chamber to the atmosphere.

## CONSTRUCTION

### 3A Components

3A added April 22, 2011

#### 3A.1 General

3A.1.1 A component of a product covered by this standard shall:

- a) Comply with the requirements for that component as indicated in this standard;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations; and
- d) Additionally comply with the applicable requirements of this standard.

*Exception No. 1: A component of a product covered by this standard is not required to comply with a specific component requirement that:*

- a) Involves a feature or characteristic not required in the application of the component in the product, or*
- b) Is superseded by a requirement in this end product standard, or*
- c) Is separately evaluated when forming part of another component, provided the component is used within its established ratings and limitations.*

*Exception No. 2: A component complying with a component standard other than those cited in this standard is acceptable if:*

- a) The component also complies with the applicable component standard as cited in this standard; or*
- b) The component standard:*
  - 1) Is compatible with the ampacity and overcurrent protection requirements in the National Electrical Code, NFPA 70, where appropriate;*
  - 2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, and*
  - 3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.*

3A.1.2 A component that is also intended to perform other functions, such as over current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

*Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.*

3A.1.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards as cited in this standard, and that involves a risk of electric shock, fire, or personal injury, shall be additionally evaluated in accordance with the applicable standard, and shall comply with items (b) – (d) of 3A.1.1.

3A.1.4 With regard to a component being additionally evaluated, reference to construction and performance requirements in another end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of UL 353.

3A.1.5 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.

### **3A.2 Attachment plugs, receptacles, connectors, and terminals**

3A.2.1 Attachment plugs and receptacles shall comply with the Standard for Attachment Plugs and Receptacles, UL 498. See 3A.2.9.

3A.2.2 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 2.8, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 in), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

*Exception: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with UL 310.*

3A.2.3 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977. See 3A.2.9.

3A.2.4 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B.

3A.2.5 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

3A.2.6 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings shall comply with the Standard for Multi-Pole Splicing Wire Connectors, UL 2459. See 3A.2.9.

3A.2.7 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

3A.2.8 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

*Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of Insulating Material, Section 8; Field Wiring Connections, Section 10; Current-Carrying Parts, Section 10; and Spacings, Section 18 of this standard. This exception does not apply to protective conductor terminal blocks.*

3A.2.9 Female devices (such as receptacles and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, a connector that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

3A.2.10 Bonding devices, ground clamps, grounding and bonding bushings and locknuts, and similar equipment, shall comply with the Standard for Grounding and Bonding Equipment, UL 467.

### **3A.3 Batteries and battery chargers**

3A.3.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642. A lithium ion multiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

3A.3.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the applicable construction and performance requirements of this standard.

3A.3.3 Rechargeable nickel metal-hydride (Ni-MH) battery cells and packs shall comply with the construction and performance requirements of this standard, or the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

### 3A.4 Electrical boxes and raceways

3A.4.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of the National Electrical Code, NFPA 70 and that comply with one of the following standards:

- a) Standard for Metallic Outlet Boxes, UL 514A;
- b) Standard for Conduit, Tubing, and Cable Fittings, UL 514B;
- c) Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C; or
- d) Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

### 3A.5 Capacitors and filters

3A.5 revised November 8, 2011

3A.5.1 A capacitor located in the line voltage circuit shall comply with the Standard for Capacitors and Suppressors for Radio- and Television-Type Appliances, UL 1414.

3A.5.2 Electromagnetic interference filters with integral enclosures shall comply with the Standard for Electromagnetic Interference Filters, UL 1283.

3A.5.3 *deleted November 8, 2011.*

#### 3A.5A Surge Protective Devices

3A.5A added November 8, 2011

3A.5A.1 Surge Protective Devices (SPDs), including air gaps and metal oxide varistors (MOVs), shall comply with the requirements in the Standard for Surge Protective Devices, UL 1449. Paragraphs 3A.5A.2 through 3A.5A.6 are applicable.

*Exception: These requirements do not apply to SPDs located in a Class 2 circuit.*

3A.5A.2 Type 1, 2, or 3 SPDs and Type 1, 2 or 3 Component Assemblies SPDs shall:

- a) Maintain a Maximum Continuous Operating Voltage (MCOV) rating equal to or greater than working voltage of the circuit connected, and
- b) Maintain the appropriate Type Rating for the application in accordance with Table 3A.1.

**Table 3A.1**  
**Type 1, 2, or 3 Ratings**

Application	Type Rating
Line side of service equipment	1
Load side of service equipment or feeder circuit applications	1 or 2
Branch circuit or control circuit applications	1 or 2 or 3

3A.5A.3 Type 4 or Type 5 discrete component SPDs and Type 4 component assemblies shall have a Maximum Continuous Operating Voltage (MCOV) rating equal to or greater than the phase-to-phase (line-to-line) voltage of the system supply.

*Exception: If the Type 4 or 5 SPDs and Type 4 Component Assemblies have been subjected to all the Current Tests in accordance with UL 1449, section 39 during its investigation, the MCOV may have a rating equal to or greater than the working voltage of the circuit connected.*

3A.5A.4 Type 4 or Type 5 discrete component SPDs and Type 4 Component Assemblies shall be rated in accordance with (a) or (b) or (c):

a) A Type 4 discrete component SPD rated for use in Type 1-3 applications may be used in applications indicated in Table 3A.1, or

b) A Type 4 discrete component SPD rated for use in Type 1 - 3 applications or "other" applications shall have an Operating Duty Cycle Voltage ( $V_p$ ) and Peak Current ( $A_p$ ) in accordance with Table 3A.2, based on the working voltage of the circuit connected, or

*Exception: For SPDs used in other than across-the-line applications such as across the contacts of a switching relay or in a non-isolated electronic circuit, the additional circuit impedance in series with the SPD can be considered when determining the required SPD ratings. The Operating Duty Cycle Peak Current ( $A_p$ ) rating of the SPD may be less than that defined in Table 3A.2 provided the  $A_p$  rating is equal to or is greater than the surge current parameters determine by a calculation that accounts for fixed series impedance inherent in the circuit. [The calculated  $A_p$  would be equal to  $V_p$  divided by the combined known impedance inherent in the circuit plus 2 ohms, which is the anticipated source impedance].*

c) A Type 5 discrete component SPD or Type 4 component assemblies shall be rated with a Nominal Discharge Current, NDC ( $I_n$ ) in accordance with Table 3A.2, based on the working voltage of the circuit connected.

*Exception: For SPDs used in other than across-the-line applications such as across the contacts of a switching relay or in a non-isolated electronic circuit, the additional circuit impedance in series with the SPD can be considered when determining the required SPD ratings. The Nominal Discharge Current rating,  $I_n$ , of the SPD may be less than that defined Table 3A.2 provided the  $I_n$  rating is equal to or is greater than the surge current parameters determine by a calculation that accounts for fixed series impedance inherent in the circuit. [The calculated  $I_n$  would be equal to  $V_p$  divided by the combined known impedance inherent in the circuit plus 2 ohms, which is the anticipated source impedance].*

**Table 3A.2  
Required Ratings of Type 4 or 5 SPDs**

SPD Circuit Characteristic				Required ratings of Type 4 or 5 SPDs	
Phase-to-Ground Voltage, Vac <sup>a</sup> by Overvoltage Category <sup>b</sup>				Minimum Operating Duty Cycle Peak voltage (kV <sub>p</sub> )(1.2 x 50 μs)	Operating Duty Cycle Peak Current or Minimum Nominal Discharge Current, NDC (In) A
I	II	III	IV		
50	-	-	-	0.33	165
100	50	-	-	0.50	250
150	100	50	-	0.80	400
300	150	100	50	1.5	750
600	300	150	100	2.5	1250
-	600	300	150	4.0	2000
-	-	600	300	6.0	3000

<sup>a</sup> For ungrounded systems or systems with one phase grounded, the phase-to-ground voltage is considered to be the same as the phase-to-phase voltage for the purposes of using this table.

<sup>b</sup> Typical examples of categories for products are given below. Users of this standard will need to establish that rated impulse voltage values are appropriate for the expected applications of the products covered.

Category IV - Primary Supply Circuit Level. Overhead lines and cable systems including distribution and its associated overcurrent protective equipment (equipment installed at the service entrance).

Category III - Distribution Circuit Level. Fixed wiring and associated equipment (not electrical loads) connected to the primary supply level, Category IV.

Category II - Load Circuit Level. Appliances and portable equipment and the like connected to the distribution level, Category III.

Category I - Signal Circuit Level. Special equipment or parts of equipment such as low-voltage electronic logic systems, remote controls, signaling and power limited (per NEC Article 725) circuits connected to the load level, Category II.

3A.5A.5 Electronic safety controls shall, in addition to the requirements noted in 3A.5A.2 and 3A.5A.3, be subjected to a subsequent transient overvoltage test sequence in the end-use equipment application as defined by the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, with the SPD installed as intended. To minimize testing of the end-use equipment involving multiple alternate SPDs sources or types, the SPD with the highest Measured Limited Voltage rating or Voltage Protective Rating, as applicable, shall be tested in the transient overvoltage test sequence. The highest rated SPD can represent multiple alternate SPDs sources or types.

*Exception: If the electronic safety control complies with the transient overvoltage test program when tested with the SPD removed, the SPD need only comply with 3A.5A.2 and 3A.5A.3*

3A.5A.6 SPDs are not permitted to be used between line / mains / non-Class 2 circuits and Class 2 circuits.

3A.5A.7 Discrete SPDs (such as MOVs, gas tubes, etc., with or without coating) shall be considered non-insulated live conductive parts. Spacings between discrete SPDs and metal parts shall comply with the spacing requirements of this standard.

### 3A.6 Gaskets and seals

3A.6.1 Gaskets and seals shall comply with the Standard for Gaskets and Seals, UL 157. Also, the requirements of Section 41, Volume Change test, and Section 42, Weight loss test, are applicable, as appropriate.

### 3A.7 Insulation systems

3A.7.1 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

3A.7.2 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

### 3A.8 Overcurrent protection

3A.8.1 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, and the applicable Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate standard for the fuse are considered to comply with this requirement.

3A.8.2 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

*Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, need not comply with UL 489.*

3A.8.3 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

3A.8.4 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

3A.8.5 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

### 3A.9 Marking and labeling systems

3A.9.1 A marking and labeling system shall comply with Standard for Marking and Labeling Systems, UL 969, under the specified environmental conditions.

*Exception: A marking or labeling system that complies with Section 47 of this standard is considered to fulfill the requirement.*

### 3A.10 Power supplies

3A.10.1 A Class 2 power supply shall comply with one of the following:

- a) The Standard for Class 2 Power Units, UL 1310; or
- b) The Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

3A.10.2 A non-Class 2 power supply shall comply with one of the following:

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

### 3A.11 Printed wiring boards

3A.11.1 Printed wiring boards, including the coatings, shall comply with the Standard for Printed-Wiring Boards, UL 796.

*Exception: A printed-wiring board in a Class 2 nonsafety circuit is not required to comply with the bonding requirements in the UL 796 if the board is separated from parts of other circuits such that loosening of the bond between the foil conductor and the base material will not result in the foil conductors or components coming in contact with parts of other circuits of the control or of the end-use product.*