

UL 1449

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Transient Voltage Surge Suppressors

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Transient Voltage Surge Suppressors, UL 1449

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In the revisions dated July 18, 2002, pages 100A and 100B have been intentionally deleted from the Standard due to the deletion or relocation of text. Please discard any previous versions of these pages from your paper copy of the Standard.

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

Future Effective Dates	References
June 6, 2003	Paragraphs 1.8.1, 11.3.1, 14.3.3, 21.1, 27.1, 34.3.3, 61.9.1, 61.10, 61.15.1, 61.17 – 61.19, 62.1, Section 29A, and Table 33.1

The new and revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated March 22, 2002. The bulletin(s) is now obsolete and may be discarded.

The revisions dated July 18, 2002 include a reprinted title page (page1) for this Standard.

The revisions dated December 7, 1999 include editorial corrections. These corrections include: updated Foreword (item D); updated Scope; title change for UL 489, UL 1363, and UL 1950; withdrawing "94" from flammability classifications; and, change of reference for ANSI/ISA MC96.1. These revisions may also include other miscellaneous editorial corrections.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. 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.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. 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.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover transient voltage surge suppressors (TVSS) intended for permanently connected, cord-connected and direct plug-in applications, designed for repeated limiting of transient voltage surges as specified in the Standard on 50 or 60 Hz power circuits not exceeding 600 V.

1.1 effective February 16, 1998

1.2 Except as indicated in 1.3, the products covered by this Standard are rated and intended for connection to circuits or supply sources having nominal voltage ratings as specified in Table 37.1.

1.2 revised March 8, 2000

1.3 A product intended for connection to an ac circuit or supply source other than that specified in 1.2 may be examined and tested in accordance with the intent of the requirements in this standard and, if found to be substantially equivalent, may be judged to comply with this Standard.

1.3 effective February 16, 1998

1.4 These requirements cover cord-connected and direct plug-in TVSS intended for indoor use and permanently connected TVSS intended for indoor and outdoor use in accordance with the National Electrical Code, ANSI/NFPA-70, and are intended for installation on the load side of the main overcurrent protection.

1.4 effective February 16, 1998

1.5 These requirements do not cover the interconnection of multiple field installed TVSS.

1.5 effective February 16, 1998

1.6 These requirements cover TVSS that may include components specifically intended to function as filters for conducted electromagnetic interference (EMI) or noise, in addition to limiting transient voltage surges.

1.6 effective February 16, 1998

1.7 These requirements cover TVSS employing circuit components intended to provide secondary protection for telephone communication circuits and circuit components intended to protect data communication or fire alarm circuits.

1.7 effective February 16, 1998

1.8 These requirements cover TVSS employing antenna connections for audio-video products.

1.8 effective February 16, 1998

1.8.1 A TVSS that has a battery backup feature or other uninterruptible power supply equipment shall also comply with the applicable requirements in UL 1778, Standard for Uninterruptible Power Supply Equipment.

Added 1.8.1 effective June 6, 2003

1.8.2 These requirements cover TVSS/Panelboard Extension Modules. These products shall also comply with UL 67, Standard for Panelboards.

1.8.2 added June 6, 2001

1.9 These requirements do not cover Secondary Surge Arresters intended for use on the line side of the main overcurrent protection.

1.9 effective February 16, 1998

1.10 These requirements do not evaluate the effect of TVSS on connected loads, the effect of TVSS on harmonic distortion of the supply voltage, the degree of attenuation provided by TVSS, nor the adequacy of the suppressed voltage rating of TVSS to protect specific connected equipment from upset or damage.

1.10 effective February 16, 1998

1.11 Deleted November 15, 2001

2 References

2.1 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.

2.1 revised June 6, 2001

3 Glossary

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

3.1 effective February 16, 1998

3.2 AC POWER INTERFACE – The electrical points where the TVSS is electrically connected to the ac power system.

3.2 effective February 16, 1998

3.3 COMBINATION WAVE – (Also called "combination surge") 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. The exact wave that is delivered is determined by the generator and instantaneous impedance to which the combination surge is applied.

3.3 effective February 16, 1998

3.4 COMPONENT – TRANSIENT VOLTAGE SURGE SUPPRESSOR – A TVSS intended solely for factory installation in another component, device or product. Examples are discrete devices such as gas discharge tubes, metal oxide varistors (MOV's), and avalanche junction diodes, or combinations of such devices, that are not provided with enclosures, have enclosures that are incomplete, or are otherwise unsuitable for direct field installation or direct connection to a branch circuit.

3.4 effective February 16, 1998

3.5 CORD CONNECTED (CC) – Any TVSS provided with a power-supply cord terminating in an attachment plug for connection of the device to a receptacle in the AC power circuit.

3.5 effective February 16, 1998

3.6 CREST (PEAK) VALUE (OF A WAVE, SURGE, OR IMPULSE) – The maximum value that a wave, surge, or impulse attains.

3.6 effective February 16, 1998

3.7 DIRECT PLUG-IN (DPI) – Any TVSS incorporating integral blades for direct insertion into a standard wall receptacle.

3.7 effective February 16, 1998

3.8 ELECTROMAGNETIC INTERFERENCE FILTER – An EMI filter is intended to attenuate unwanted radio-frequency signals (such as noise or interference) generated from electromagnetic sources. EMI filters consist of capacitors and inductors used alone or in combination with each other and may be provided with resistors.

3.8 effective February 16, 1998

3.9 EQUIPMENT UNDER TEST (EUT) – Refers to the TVSS device being tested.

3.9 effective February 16, 1998

3.10 FAULT CURRENT – The current from the connected power system that flows in a short circuit.

3.10 effective February 16, 1998

3.11 FOLLOW (POWER) CURRENT – The current from the connected power source that flows through a TVSS during and following the passage of discharge current. Examples of devices that permit follow current are gas discharge tubes and thyristors.

3.11 effective February 16, 1998

3.12 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolating source (such as a transformer, optical isolator, limiting impedance or electro-mechanical relay) and having no direct connection back to the primary circuit (other than through the grounding means). A secondary circuit that has a direct connection back to the primary circuit is considered part of the primary circuit.

3.12 effective February 16, 1998

3.12.1 LET-THROUGH ENERGY (I^2t)– The circuit energy developed as a result of current flow between the initiation of a fault current and the clearing of the circuit.

3.12.1 added June 6, 2001

3.13 MAIN OVERCURRENT PROTECTION – The first overcurrent protection device between the distribution transformer secondary and the service entrance.

3.13 effective February 16, 1998

3.13.1 MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)– The maximum designated root-mean-square (rms) value of the power frequency voltage that may be continuously applied to the mode of protection of a TVSS.

3.13.1 added June 6, 2001

3.14 MEASURED LIMITING VOLTAGE – The maximum magnitude of voltage, measured at the leads, terminals, receptacle contacts, and similar locations within 100 microseconds after the application of an impulse of specified waveshape and amplitude.

3.14 revised June 6, 2001

3.15 NOMINAL SYSTEM VOLTAGE – A nominal value assigned to designate a system of a given voltage class in accordance with ANSI C84.1, Table 1. For the purpose of this standard, nominal system voltages include, but are not limited to, 120, 208, 240, 277, 347, 480, 600 Vac.

3.15 effective February 16, 1998

3.16 NORMAL OPERATING VOLTAGE RATING – The normal ac power frequency voltage rating assigned to a TVSS by the manufacturer. For a TVSS, other than a Component-TVSS, it is generally equal to the nominal value of the root-mean-square power-frequency phase voltage of the ac circuit (for example, 120, 208, 240, 347, 480, or 600 Vrms).

3.16 effective February 16, 1998

3.17 ONE-PORT TVSS – A TVSS having provisions (terminals, leads, plug) for connection to the ac power circuit but no provisions (terminals, leads, receptacles) for supplying current to ac power loads.

3.17 effective February 16, 1998

3.17.1 PEAK LET-THROUGH CURRENT (I_p)– The maximum instantaneous current through a circuit during a fault.

3.17.1 added June 6, 2001

3.18 PERMANENTLY CONNECTED (PC) – Any TVSS provided with terminals or leads for field connection to wiring systems in accordance with the National Electrical Code, ANSI/NFPA-70. This includes receptacle type TVSS intended for installation in outlet boxes.

3.18 effective February 16, 1998

3.19 PHASE ANGLE – The point on the ac power sine wave, expressed in terms of electrical degrees between 0 and 360, at which the transient surge is applied measured from the point at which the sine wave crosses the zero axis with a positive slope.

3.19 effective February 16, 1998

3.20 POWERED TESTING – Refers to surge testing that is done while the TVSS is electrically connected to the ac power system, at the nominal system voltage, or the manufacturer's operating voltage rating, whichever is greater.

3.20 effective February 16, 1998

3.21 PRIMARY CIRCUIT – A circuit in which the wiring and components are conductively connected to the AC power interface.

3.21 effective February 16, 1998

3.22 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist at any part if:

- a) The potential between the part and earth ground or any other accessible part is more than 30 V rms (42.4 V peak), and
- b) The continuous current flow through a 1500 ohm resistor connected across the potential exceeds 0.5 mA.

3.22 effective February 16, 1998

3.23 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:

- a) The open circuit voltage is more than 30 Vrms (42.4 V peak) and the energy available to the circuit under any condition of load including short circuit, results in a current of 8 A or more after 1 minute of operation, or

b) A power of more than 15 watts can be delivered into an external resistor connected between the two points.

3.23 effective February 16, 1998

3.23.1 SERVICEABLE PART— A part or component of a TVSS that is intended to be replaced or otherwise serviced during the life of the TVSS.

3.23.1 added June 6, 2001

3.24 SUPPLEMENTARY PROTECTION DEVICE – A device intended for use as overcurrent, over- or under-voltage, or over-temperature protection within electrical equipment where branch circuit overcurrent protection is already provided, or is not required.

3.24 effective February 16, 1998

3.25 SUPPRESSED VOLTAGE RATING (SVR) – A rating (or ratings) selected by the manufacturer from Table 60.1 and based on the measured limiting voltage determined during the transient-voltage surge suppression test.

3.25 effective February 16, 1998

3.26 SURGE – A transient wave of current, potential or power in an electric circuit. For the purposes of this standard, surges do not include temporary overvoltages (TOV) consisting of an increase in the power frequency voltage for several cycles.

3.26 effective February 16, 1998

3.27 SURGE PROTECTIVE DEVICE (SPD) – A device composed of any combination of linear or non-linear circuit elements and intended for limiting surge voltages on equipment by diverting or limiting surge current; it prevents continued flow of follow (power) current and is capable of repeating these functions as specified.

3.27 effective February 16, 1998

3.28 TRANSIENT VOLTAGE SURGE SUPPRESSOR (TVSS) – A surge protective device intended for connection electrically on the load side of the main overcurrent protection in circuits not exceeding 600 volts rms.

3.28 effective February 16, 1998

3.29 TWO-PORT TVSS – A TVSS having provisions (terminals, leads, plug) for connection to the ac power circuit and provisions (terminals, leads, receptacles(s)) for supplying current to one or more ac power loads. TVSS provided with a minimum of two adjacent terminals for each circuit conductor may be considered and tested as a two-port TVSS.

3.29 effective February 16, 1998

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this Standard.

4.1 revised June 6, 2001

4.2 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.

4.2 revised June 6, 2001

4.3 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.

4.3 revised June 6, 2001

5 Units of Measurement

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

5.1 revised June 6, 2001

5.2 All units of voltage and current specified in this standard are root-mean-square values unless otherwise indicated.

5.2 effective February 16, 1998

CONSTRUCTION

6 General

6.1 A TVSS shall be so formed and assembled that it has the strength and rigidity necessary to withstand the handling that can be encountered during shipment, installation and use without increasing the risk of fire, electric shock, and injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other defects.

6.1 effective February 16, 1998

6.2 A direct plug-in type TVSS shall comply with the general requirements for current taps and adapters in the Standard for Attachment Plugs and Receptacles, UL 498.

6.2 effective February 16, 1998

6.3 A cord-connected type TVSS shall comply with the general requirements in the Standard for Relocatable Power Taps, UL 1363.

6.3 revised December 7, 1999

6.4 A TVSS with a maximum continuous operating voltage (MCOV) greater than the rated system operating voltage shall be tested and comply with all construction and performance requirements at the MCOV.

6.4 added June 6, 2001

7 Enclosure

7.1 Permanently-connected TVSS

7.1.1 General

7.1.1.1 An enclosure and a part of an enclosure, such as door, cover, or tank, shall be provided with means for firmly securing it in place.

7.1.1.1 effective February 16, 1998

7.1.1.2 An enclosure other than a Type 1 (indoor use only) enclosure shall comply with the requirements for the type designation indicating the conditions for which it is intended, as specified, for Enclosure Types, in the Standard for Enclosures for Electrical Equipment, UL 50.

7.1.1.2 effective February 16, 1998

7.1.1.3 Sheet-metal screws threading directly into metal shall not be used to attach a cover, door, or other part that is to be removed to install field wiring or for operation of the equipment. Sheet-metal screws may thread into sheet-metal nuts that are permanently mounted and protected against corrosion. Machine screws and self-tapping machine screws may thread-directly into sheet-metal walls.

7.1.1.3 effective February 16, 1998

7.1.1.4 Sheet-metal screws mounting internal components that are not removed for installation or operation may thread directly into metal.

7.1.1.4 effective February 16, 1998

7.1.1.5 A snap-on cover giving access to uninsulated live parts that does not require a tool for removal shall perform acceptably when subjected to the Snap-On Cover Tests, Section 49.

7.1.1.5 effective February 16, 1998

7.1.1.6 An enclosure cover shall be hinged if it gives access to a fuse or any other overload-protective device, the functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation of the TVSS.

Exception: A hinged cover is not required for a TVSS when the fuse or overload protector is not in series with a load circuit and opens only in the event of a malfunction of a discrete suppression component.

7.1.1.6 effective February 16, 1998

7.1.1.7 A door or cover giving access to a fuse shall shut closely against a 6.4 mm (1/4 inch) rabbet or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the walls of the box and shall overlap the edges of the box by not less than 12.7 mm (1/2 inch). A combination of flange and rabbet or a construction that affords equivalent protection is acceptable.

7.1.1.7 effective February 16, 1998

7.1.1.8 Strips used to provide rabbets, or angle strips fastened to the edges of a door, shall be secured at:

- a) Not less than two points,
- b) Not more than 38.1 mm (1-1/2 inches) from each end of strip, and
- c) Points between these end fastenings to be not more than 152 mm (6 inches) apart.

7.1.1.8 effective February 16, 1998

7.1.1.9 Deleted June 6, 2001

7.1.2 Cast metal

7.1.2.1 Cast metal for an enclosure shall be at least 3.2 mm (1/8 inch) thick at every point, of greater thickness at reinforcing ribs and door edges, and not less than 6.4 mm (1/4 inch) thick at tapped holes for conduit.

Exception No. 1: At other than at plain or threaded conduit holes, die-cast metal shall not be less than 2.4 mm (3/32 inch) thick for an area greater than 154.8 cm² (24 square inches) or having any dimensions greater than 152 mm (6 inches), and shall not be less than 1.6 mm (1/16 inch) thick for an area of 154.8 cm² (24 square inches) or less and having no dimension greater than 6 inches (152 mm). The area limitation for metal that is 1.6 mm (1/16 inch) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

Exception No. 2: Cast metal that is a minimum 0.89 mm (0.035 inch) thick may be employed instead of 1/16 inch-thick (1.6 mm) die-cast metal if the enclosure is not intended to be used as a splice box and if the voltage rating of the complete device is such that the voltage between any two conductors is 250 V or less and is limited to direct current or single-phase alternating current.

7.1.2.1 effective February 16, 1998

7.1.3 Sheet metal

7.1.3.1 The thickness of a sheet-metal enclosure shall not be less than that indicated in Tables 7.1 and 7.2, except that uncoated steel shall not be less than 0.81 mm (0.032 inch) thick, zinc-coated steel shall not be less than 0.86 mm (0.034 inch) thick, and nonferrous metal shall not be less than 1.14 mm (0.045 inch) thick at points at which a wiring system is to be connected.

7.1.3.1 effective February 16, 1998

7.1.3.2 Tables 7.1 and 7.2 are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

7.1.3.2 effective February 16, 1998

7.1.3.3 With reference to Tables 7.1 and 7.2, a supporting frame is a structure of angle or channel, or a folded rigid section of sheet metal that is firmly attached to and has essentially the same outside dimensions as the enclosure surface and that has such torsional rigidity as to resist bending moments that may be applied by the enclosure surface when it is deflected. A construction that is considered to have equivalent reinforcing is one that produces a structure that is as rigid as one built with a frame of angles or channels. Constructions that are considered to be without supporting frame include:

- a) Single sheet with formed flanges (formed edges),
- b) A single sheet that is corrugated or ribbed,
- c) An enclosure surface loosely attached to a frame; for example, with spring clips, and
- d) An enclosure surface having an unsupported edge.

7.1.3.3 effective February 16, 1998

7.1.4 Nonmetallic

7.1.4.1 The enclosure shall comply with the applicable mechanical/electrical property considerations, flammability, moisture-absorptive properties and thermal requirements for fixed and stationary equipment as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.1.4.1 effective February 16, 1998

7.1.4.2 The enclosure shall comply with the Non-Metallic Enclosure Conduit Connection, Enclosure Impact, Crushing and Mold-Stress Relief Test requirements of Sections 50, 51, 52, and 53, respectively, of this Standard.

7.1.4.2 effective February 16, 1998

7.1.4.3 A part such as a dial or nameplate that is considered to be a part of the enclosure shall be of metal or other material as specified for the enclosure in 7.1.2.1 – 7.1.3.2.

7.1.4.3 effective February 16, 1998

7.1.4.4 A nonmetallic part such as a reset knob, lever or button protruding through a hole in the enclosure shall be of a material classified as V-0, V-1, V-2 as determined by the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, if the area of the hole is not greater than the area of a 22.2 mm (7/8 inch) diameter circle. Nonmetallic parts protruding through a hole, the area of which is greater than the area of a 22.2 mm (7/8 inch) diameter circle, shall be made of materials that comply with the requirements in 7.1.4.1.

7.1.4.4 revised December 7, 1999

7.1.5 Wiring openings

7.1.5.1 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall or if an equivalent construction is employed, there shall not be less than three or more than five threads in the metal. The construction of the device shall be such that a conduit bushing can be properly attached. If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall not be less than 3-1/2 threads in the metal. In addition, there shall be a smooth, well-rounded inlet hole for the conductors that provides protection to the conductors equivalent to that provided by a standard conduit bushing, and the inlet hole shall have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

7.1.5.1 effective February 16, 1998

Table 7.1
Thickness of metal for enclosures – carbon steel or stainless steel

Table 7.1 effective February 16, 1998

Without support frame ^a				With supporting frame or equivalent reinforcing ^a				Minimum acceptable thickness			
Maximum width ^b		Maximum length ^c		Maximum width ^b		Maximum length		Uncoated		Metal coated	
cm	(inches)	cm	(inches)	cm	(inches)	cm	(inches)	mm	(inches)	mm	(inches)
10.2	(4.0)	Not limited		15.0	(6.25)	Not limited		0.51	(0.020)	0.58	(0.023)
12.1	(4.75)	14.6	(5.75)	17.1	(6.75)	21.0	(8.25)				
15.2	(6.0)	Not limited		24.1	(9.5)	Not limited		0.66	(0.026)	0.74	(0.029)
17.8	(7.0)	22.2	(8.75)	25.4	(10.0)	31.8	(12.5)				
20.3	(8.0)	Not limited		30.5	(12.0)	Not limited		0.81	(0.032)	0.86	(0.034)
22.9	(9.0)	29.2	(11.5)	33.0	(13.0)	40.6	(16.0)				
31.8	(12.5)	Not limited		49.5	(19.5)	Not limited		1.07	(0.042)	1.14	(0.045)
35.6	(14.0)	45.7	(18.0)	53.3	(21.0)	63.5	(25.0)				
45.7	(18.0)	Not limited		68.6	(27.0)	Not limited		1.35	(0.053)	1.42	(0.056)
50.8	(20.0)	63.5	(25.0)	73.7	(29.0)	91.4	(36.0)				
55.9	(22.0)	Not limited		83.8	(33.0)	Not limited		1.52	(0.060)	1.60	(0.063)
63.5	(25.0)	78.7	(31.0)	88.9	(35.0)	109.2	(43.0)				
63.5	(25.0)	Not limited		99.1	(39.0)	Not limited		1.70	(0.067)	1.78	(0.070)
73.7	(29.0)	91.4	(36.0)	104.1	(41.0)	129.5	(51.0)				
83.8	(33.0)	Not limited		129.5	(51.0)	Not limited		2.03	(0.080)	2.13	(0.084)
96.5	(38.0)	119.4	(47.0)	137.2	(54.0)	167.6	(66.0)				
106.7	(42.0)	Not limited		162.6	(64.0)	Not limited		2.36	(0.093)	2.46	(0.097)
119.4	(47.0)	149.9	(59.0)	172.7	(68.0)	213.4	(84.0)				
132.1	(52.0)	Not limited		203.2	(80.0)	Not limited		2.74	(0.108)	2.82	(0.111)
152.4	(60.0)	188.0	(74.0)	213.4	(84.0)	261.6	(103.0)				
160.0	(63.0)	Not limited		246.4	(97.0)	Not limited		3.12	(0.123)	3.20	(0.126)
185.4	(73.0)	228.6	(90.0)	261.6	(103.0)	322.6	(127.0)				

^a See 7.1.3.3.

^b The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have common supports and be made of a single sheet.

^c Not limited applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

Table 7.2
Thickness of metal for enclosures of aluminum, copper, or brass

Table 7.2 effective February 16, 1998

Without support frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum acceptable thickness
Maximum width ^b cm (inches)	Maximum length ^c cm (inches)	Maximum width ^b cm (inches)	Maximum length cm (inches)	
7.6 (3.0)	Not limited	17.8 (7.0)	Not limited	0.58 (0.023)
8.9 (3.5)	10.2 (4.0)	21.6 (8.5)	24.1 (9.5)	
10.2 (4.0)	Not limited	25.4 (10.0)	Not limited	0.74 (0.029)
12.7 (5.0)	15.2 (6.0)	26.7 (10.5)	34.3 (13.5)	
15.2 (6.0)	Not limited	35.6 (14.0)	Not limited	0.91 (0.036)
16.5 (6.5)	20.3 (8.0)	38.1 (15.0)	45.7 (18.0)	
20.3 (8.0)	Not limited	48.3 (19.0)	Not limited	1.14 (0.045)
24.1 (9.5)	29.2 (11.5)	53.3 (21.0)	63.5 (25.0)	
30.5 (12.0)	Not limited	71.1 (28.0)	Not limited	1.47 (0.058)
35.6 (14.0)	40.6 (16.0)	76.2 (30.0)	94.0 (37.0)	
45.7 (18.0)	Not limited	106.7 (42.0)	Not limited	1.91 (0.075)
50.8 (20.0)	63.4 (25.0)	114.3 (45.0)	139.7 (55.0)	
63.5 (25.0)	Not limited	152.4 (60.0)	Not limited	2.41 (0.095)
73.7 (29.0)	91.4 (36.0)	162.6 (64.0)	198.1 (78.0)	
94.0 (37.0)	Not limited	221.0 (87.0)	Not limited	3.10 (0.122)
106.7 (42.0)	134.6 (53.0)	236.2 (93.0)	289.6 (114.0)	
132.1 (52.0)	Not limited	312.4 (123.0)	Not limited	3.89 (0.153)
152.4 (60.0)	188.0 (74.0)	330.2 (130.0)	406.4 (160.0)	

^a See 7.1.3.3.
^b The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have common supports and be made of a single sheet.
^c Not limited applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

7.1.5.2 An enclosure threaded for support by rigid conduit shall provide at least five full threads for engaging the conduit.

7.1.5.2 effective February 16, 1998

7.1.5.3 Clamps and fasteners for the attachment of raceways, such as conduit, electrical metallic tubing, armored cable, nonmetallic flexible tubing, nonmetallic-sheathed cable, or service cable, that are supplied as a part of an enclosure shall comply with the requirements in the Standards for Metallic Outlet Boxes, UL 514A; Fittings for Conduit and Outlet Boxes, UL 514B; and Nonmetallic Outlet Boxes, and Covers, UL 514C.

7.1.5.3 effective February 16, 1998

7.1.5.4 A knockout in a sheet-metal enclosure shall be reliably secured but shall be capable of being removed without undue deformation of the enclosure.

7.1.5.4 effective February 16, 1998

7.1.5.5 A knockout shall be provided with a flat surrounding surface for proper seating of a conduit bushing, and shall be so located that installation of a bushing at any knockout likely to be used during installation will not result in unacceptable spacing between uninsulated live parts and the bushing.

7.1.5.5 effective February 16, 1998

7.1.5.6 For an enclosure not provided with conduit openings, or knockouts, spacings not less than the minimum required in Spacings, Section 18 shall be provided between uninsulated live parts and a conduit bushing installed at any location likely to be used during installation. Permanent marking on the enclosure, a template, or a full-scale drawing furnished with the device may be used to limit such a location.

7.1.5.6 effective February 16, 1998

7.1.5.7 In measuring a spacing between an uninsulated live part and a bushing installed in the knockout referred to in 7.1.5.5 and 7.1.5.6, it is to be assumed that a bushing having the dimensions indicated in Table 7.3 is in place, and that a single locknut is installed on the outside of the enclosure.

7.1.5.7 effective February 16, 1998

Table 7.3
Dimensions of bushings

Table 7.3 effective February 16, 1998

Trade size of conduit, inches	Bushing dimensions, mm (inches)	
	Overall diameter	Height
1/2	25.4 (1)	9.5 (3/8)
3/4	31.4 (1-15/64)	10.7 (27/64)
1	40.5 (1-19/32)	13.1 (33/64)
1-1/4	49.2 (1-15/16)	14.3 (9/16)
1-1/2	56.0 (2-13/64)	15.1 (19/32)
2	68.7 (2-45/64)	15.9 (5/8)
2-1/2	81.8 (3-7/32)	19.1 (3/4)
3	98.4 (3-7/8)	20.6 (13/16)
3-1/2	112.7 (4-7/16)	23.8 (15/16)

7.1.5.8 No wire other than wires leading to a part mounted on a door or cover shall be brought out through the door or cover.

7.1.5.8 effective February 16, 1998

7.2 Cord-connected TVSS

7.2.1 General

7.2.1.1 The enclosure shall not have any openings or knockouts that may be used for permanent mounting or connection to a permanent wiring system.

7.2.1.1 effective February 16, 1998

7.2.1.2 An opening in an enclosure shall have such size and shape – or shall be so covered by screening or barrier or by an expanded, perforated, or louvered panel – that a test rod having a maximum diameter of 1.6 mm (1/16 inch) shall be prevented from contacting uninsulated current-carrying parts. Accessibility shall be evaluated by performing the enclosure accessibility test in 55A.1.

7.2.1.2 revised June 6, 2001

7.2.1.3 A keyhole slot, notch, or similar means for temporary mounting, if provided, shall be so located that the supporting screws or the like cannot damage any electrical insulation or reduce spacings to live parts.

7.2.1.3 effective February 16, 1998

7.2.1.4 A barrier that covers a mounting hole and thereby forms part of the required enclosure shall be subjected to the Mounting Hole Barrier Tests of Section 54.

7.2.1.4 effective February 16, 1999

7.2.2 Metallic

7.2.2.1 A metal enclosure of a temporary power tap shall have a minimum thickness in accordance with Table 7.4.

7.2.2.1 effective February 16, 1998

Table 7.4
Minimum acceptable thicknesses of enclosure metal

Table 7.4 effective February 16, 1998

Metal	At small, flat unreinforced surfaces and at surfaces of a shape or size to provide adequate mechanical strength		At relatively larger unreinforced flat surfaces	
	mm	(inch)	mm	(inch)
Die-cast metal	1.2	(3/64)	2.0	(5/64)
Cast malleable iron	1.6	(1/16)	2.4	(3/32)
Other cast metal	2.4	(3/32)	3.2	(1/8)
Uncoated sheet steel	0.66	(0.026)	0.66	(0.026)
Galvanized sheet steel	0.74	(0.029)	0.74	(0.029)
Nonferrous sheet metal	0.91	(0.036)	0.91	(0.036)

7.2.3 Nonmetallic

7.2.3.1 A nonmetallic enclosure shall comply with the applicable mechanical/electrical property considerations, flammability and thermal requirements for non-attended, non-intermittent duty portable equipment as specified in the Standard for Polymeric Materials— Use in Electrical Equipment Evaluations, UL 746C.

7.2.3.1 effective February 16, 1998

7.2.3.2 The enclosure shall comply with the Strain Relief, Enclosure Impact, Crushing, and Mold Stress-Relief Distortion test requirements of Sections 46, 51, 52, and 53 respectively, of this Standard.

7.2.3.2 effective February 16, 1998

7.3 Direct plug-in TVSS

7.3.1 General

7.3.1.1 The enclosure shall comply with the enclosure requirements for current taps and adapters in the Standard for Attachment Plugs and Receptacles, UL 498, and with the requirements specified in 7.2.1.1, 7.2.3.1 and 7.2.3.2, as applicable.

Exception: The enclosure may have means for permanent attachment to a (duplex) receptacle rated 15A, 125V. When provided with means for permanent attachment, the TVSS need not comply with requirements specified in 7.3.1.2 and 7.3.1.3 but shall comply with the Grounding Contact Test as specified in 16.9.

7.3.1.1 effective February 16, 1998

7.3.1.2 A unit shall:

- a) Have a mass of 0.79 kg (28 ounces) or less, and
- b) Comply with the specifications in Table 7.5.

7.3.1.2 effective February 16, 1998

Table 7.5
Specifications for plug-in products

Table 7.5 effective February 16, 1998

$WY/Z \leq 1.36 \text{ kg (48 ounces)}$ $WY/S \leq 1.36 \text{ kg (48 ounces)}$ $WX \leq 0.56 \text{ N}\cdot\text{m (80 ounce-inches)}$
<i>in which:</i> <i>W is the weight in kg (ounces)</i> <i>Y is the distance, in mm (inches), illustrated in Figure 7.1</i> <i>Z is the shorter distance, in mm (inches), of Z_1 or Z_2 illustrated in Figure 7.1</i> <i>S is the shorter distance, in mm (inches), of S_1 or S_2 illustrated in Figure 7.1</i> <i>X is the longer distance, in mm (inches), of X_1 or X_2 illustrated in Figure 7.1</i>

7.3.1.3 When determining the moment and weight specified in 7.3.1.2, a mounting tab is not to be included in measurements of the linear dimensions for the purpose of determining moments unless:

- a) The tab and enclosure withstand the Enclosure Impact Test, Section 51, with one impact on the tab itself, without deformation, and
- b) For a non-metallic unit having an integral tab, the tab and enclosure do not distort when subjected to the Mold Stress-Relief Distortion Test, Section 53.

7.3.1.3 effective February 16, 1998

7.3.1.4 When inserted in a parallel-blade duplex receptacle, any part of a unit shall not interfere with full insertion of an attachment plug into the adjacent receptacle.

Exception: A unit that renders the adjacent receptacle completely unusable is acceptable.

7.3.1.4 effective February 16, 1998

7.3.1.5 The enclosure of a unit shall be capable of being gripped for removal from the receptacle to which it is connected, and the perimeter of the face section from which the blades project shall not be less than 6.4 mm (1/4 inch) from any point on either blade.

7.3.1.5 effective February 16, 1998

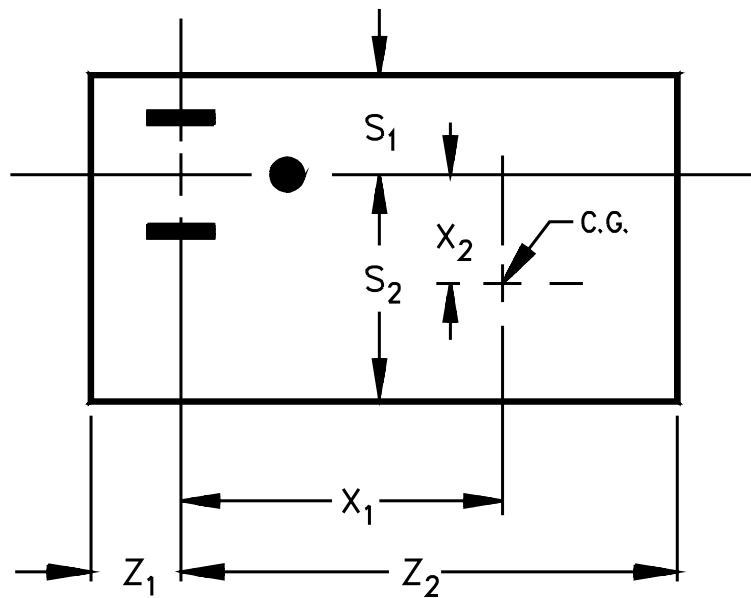
8 Protection Against Corrosion

8 effective February 16, 1998

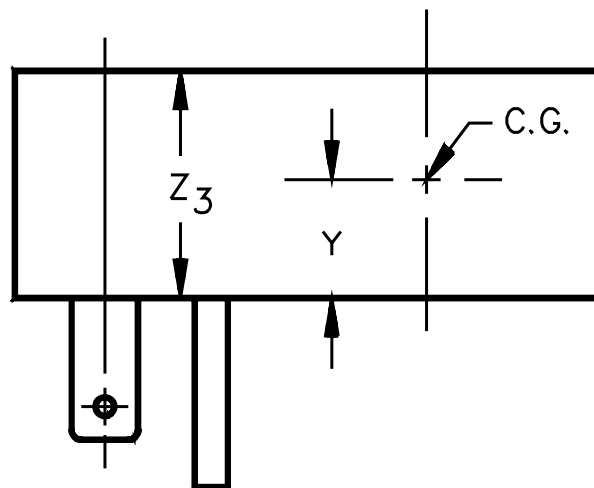
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Figure 7.1
Dimensions of a plug-in product

Figure 7.1 effective February 16, 1998



FRONT VIEW



SIDE VIEW

C.G. = Center of Gravity

CP100

8.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means. This applies to all springs and other parts upon which proper mechanical operation may rely.

Exception No. 1: Parts such as bearings, thermal elements, if such protection is impracticable.

Exception No. 2: Small minor parts of iron or steel such as washers, screws, or bolts that are not current-carrying and are not in the equipment grounding conductor path, if corrosion of such unprotected parts is not likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 3: Parts made of stainless steel, properly polished or treated if necessary.

8.2 The requirements in 8.1 apply to all enclosing cases whether of sheet steel or cast iron, and to all springs and other parts upon which mechanical operation may depend.

9 Insulating Materials

9 effective February 16, 1998

9.1 General

9.1.1 A barrier or integral part, such as an insulating washer or bushing, and a base or support for the mounting of live parts, shall be of a moisture-resistant material that will not be damaged by the temperature and stresses to which it may be subjected under conditions of actual use.

9.1.2 An insulating material is to be investigated with respect to its acceptability for the application in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Materials, such as mica, ceramic, or some molded compounds are usually acceptable for use as the sole support of live parts. If it is necessary to investigate a material to determine its acceptability, consideration is to be given to such factors as its mechanical strength, resistance to ignition sources, dielectric strength, insulation resistance, and heat-resistant properties in both the aged and unaged conditions, the degree to which it is enclosed, and any other features affecting the risk of fire and electric shock.

9.1.3 Ordinary vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as sole support for uninsulated live parts.

9.2 Bushings

9.2.1 At a point where a cord or lead passes or is intended to pass through an opening in a wall, barrier, or enclosure case, there shall be a bushing or the equivalent that shall be secured in place and that shall have a smoothly rounded surface against which the lead or cord may bear.

9.2.2 If the cord hole is in wood, porcelain, phenolic composition, or other nonconducting material, a smoothly rounded surface is considered to be the equivalent of an insulating bushing.

9.2.3 Ceramic materials and some molded compositions are acceptable generally for insulating bushings.

9.2.4 A fiber bushing shall not be less than 1.2 mm (3/64 inch) thick, and shall be so formed and secured in place so as not to be affected adversely by conditions of ordinary moisture. It shall be employed only where it is not subjected to a temperature higher than 90°C (194°F) under normal operating conditions.

9.2.5 If an insulated metal grommet is employed instead of an insulating bushing, the insulating material shall not be less than 0.8 mm (1/32 inch) thick and shall completely fill the space between the grommet and the metal in which it is mounted.

10 Current-Carrying Parts

10 effective February 16, 1998

10.1 A current-carrying part shall have mechanical strength, an ampacity acceptable for the service, and shall be of metal that is acceptable for the particular application.

10.2 Uninsulated live parts, including terminals, shall be so secured to their supporting surfaces – by methods other than friction between surfaces – so as not to turn or shift in position if such motion may result in reduction of spacings to less than those required elsewhere in this Standard.

10.3 A lockwasher is generally acceptable at a terminal or connection stud.

11 Internal Wiring

11.1 Wire employed for the internal wiring of a device shall be acceptable for the particular application.

11.1 effective February 16, 1998

11.2 The internal wiring shall be rated for the voltage and temperature to which it may be subjected to under normal operating conditions.

11.2 effective February 16, 1998

11.3 No. 18 AWG [0.82 mm²(0.04 inches)] rubber-covered wire when provided as part of a device shall be at least Type RFH-1 or equivalent, if a potential of 300 V or less is involved. Nos. 18 and 16 AWG [0.82 and 1.3 mm²(0.04 and 0.05 inches)] wires shall be at least Type RFH-2 or equivalent, if a potential greater than 300 V is involved. A No. 14 AWG [2.1 mm²(0.06 inches)] or larger wire shall be Type T, RH or RHW or equivalent.

11.3 effective February 16, 1998

11.3.1 For a permanently-connected TVSS, line and ground connecting conductors shall not be smaller than No. 14 AWG (2.1 mm²) copper or No. 12 AWG (3.3 mm²) aluminum.

Effective date for 11.3.1 changed from June 6, 2002 to June 6, 2003

11.4 If the use of a short length of insulated conductor – such as a short coil lead – is not practical, electrical insulating tubing may be used on each conductor. The tubing is not to be subjected to sharp bends, tension, compression, or repeated flexing or to contact with sharp edges, projections, or corners. The wall thickness shall comply with the individual requirements for the tubing.

11.4 effective February 16, 1998

11.5 Extruded insulating tubing shall be rated for temperature and voltage application and shall comply with the requirements in the Standard for Extruded Insulating Tubing, UL 224.

11.5 effective February 16, 1998

11.6 The internal wiring and electrical connections between parts of a device shall be protected or enclosed.

11.6 effective February 16, 1998

11.7 Wires within an enclosure, compartment, raceway, or the like shall be so positioned or protected that contact with any rough, sharp, or movable part is prevented.

11.7 effective February 16, 1998

No Text on This Page

11.8 A screw provided for use in mounting the device to an outlet box or other enclosures shall not project more than 22.2 mm (7/8 inch) beyond the strap or cover and shall have flat or blunt ends. The end of the screw may have thread-cleaning slots or grooves but shall not have any burrs, fins, or other sharp edges that could damage wiring.

11.8 effective February 16, 1998

11.9 Screw threads, including those of sheet metal screws, shall not be exposed for more than 4.76 mm (3/16 inch) inside a compartment containing wiring and shall be so located that contact with conductor insulation is unlikely.

11.9 effective February 16, 1998

11.10 Suitably insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of the product.

11.10 effective February 16, 1998

11.11 A bare conductor or a conductor utilizing noncarbonizable beads for insulation shall not be employed outside of an enclosure device. A bare conductor, if used within an enclosure, shall be so supported that the spacings required elsewhere in this Standard will be maintained. If necessary, a force of 10 N (2.25 lbf) shall be applied to any point on internal parts in an endeavor to reduce the spacing while taking measurements.

11.11 effective February 16, 1998

11.12 All splices and connections shall be mechanically secure and shall make reliable electrical contact. Solder connections shall be made mechanically secure prior to soldering. A lead is considered to be mechanically secure if it is:

- a) Wrapped at least halfway (180 degrees) around a terminal,
- b) Provided with at least one right angle bend when passed through an eyelet or opening, or
- c) Twisted with other conductors.

Exception: Wiring through openings on printed wiring boards need not be mechanically secure before soldering.

11.12 effective February 16, 1998

11.13 A splice shall be provided with insulation equivalent to that of the wires involved if the required spacing between the splice and other metal parts is not permanently maintained.

11.13 effective February 16, 1998

11.14 In determining whether splice insulation consisting of coated-fabric, thermoplastic, or another type of tape or tubing is acceptable, consideration is to be given to such factors as mechanical strength, dielectric properties, heating and moisture-resistant characteristics, and the like.

11.14 effective February 16, 1998

11.15 Where stranded wiring is connected to a wire-binding screw, the construction shall be such that any loose strand of wire is prevented from contacting live parts of opposite polarity or dead metal parts that may be grounded. This can be accomplished by use of upturned lugs on the terminal plate, pressure terminal connectors, soldering lugs, crimped eyelets, or equivalent means.

11.15 effective February 16, 1998

11.16 Soldered stranded (bunch tinned/solder dipped/tinned bonded) wire shall not be used with the terminals of a receptacle unless the receptacle has been investigated for such use.

11.16 effective February 16, 1998

11.17 The internal wiring of a cord-connected two-port TVSS shall be at least of the same gauge (AWG) as the power-supply cord.

Exception No. 1: Non-load current-carrying conductors need not be of the same gauge as the power-supply cord.

Exception No. 2: Smaller AWG conductors may be used if:

- a) Supplementary overcurrent protection is provided and;*
- b) The results of the Temperature Test (Section 33), the Fault Current Test (Section 39) for grounding-path conductors only, and the Overcurrent Test (Section 40) are acceptable using the smaller AWG size.*

11.17 revised December 7, 1999

11.18 The internal wiring of a direct plug-in two-port TVSS shall be at least of the same gauge (AWG) as the branch-circuit conductors on which the device is intended to be installed.

Exception No. 1: Non-load current-carrying conductors need not be of the same gauge as the branch circuit conductors.

Exception No. 2: Smaller AWG conductors may be used if:

- a) Supplementary overcurrent protection is provided and;*
- b) The results of the Temperature Test (Section 33), the Fault Current Test (Section 39) for grounding-path conductors only, and the Overcurrent Test (Section 40) are acceptable using the smaller AWG size.*

11.18 revised December 7, 1999

12 Supplementary Protection

12.1 Supplementary overcurrent or overtemperature protection, if provided in TVSS, shall be readily replaceable or resettable.

Exception: The supplementary protection need not be readily replaceable or resettable if, when it opens, the entire TVSS is intended to be replaced and the supplementary protection is inaccessible to the user by the use of ordinary tools (such as slotted or phillips type screwdrivers, pliers, etc.), or the unit is otherwise sealed.

12.1 effective February 16, 1998

12.2 A supplementary overcurrent protection device provided in a permanently connected two-port TVSS, not in series with the load, a permanently connected one-port TVSS, a cord connected TVSS or a direct plug-in TVSS, shall be capable of clearing a fault current of not less than that indicated in Table 12.1 and shall comply with the requirements in the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

Exception No. 1: A fuse that is capable of clearing a fault current of not less than that indicated in Table 12.1 and complies with the requirements in the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14, is able to be used as a supplementary protection device.

Exception No. 2: A circuit breaker or fuse that complies with 12.3 is able to be used as a supplementary protector.

12.2 revised June 6, 2001

12.2.1 A thermal cutoff device provided in a permanently connected TVSS, a cord connected TVSS or a direct plug-in TVSS and not connected in series with the load, shall comply with the requirements in the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020.

12.2.1 added June 6, 2001

12.2.2 A thermal cutoff device provided in a cord connected TVSS or a direct plug-in TVSS and connected in series with the load, shall be capable of clearing a fault current of not less than that indicated in Table 12.1 and shall comply with the requirements in the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020.

12.2.2 added June 6, 2001

12.3 A circuit breaker or fuse, provided in series with the load in a permanently connected two-port TVSS, shall be suitably rated, capable of clearing a fault current of not less than that indicated in Table 12.1 and acceptable for branch-circuit protection in accordance with the National Electrical Code, ANSI/NFPA-70 – for example, circuit breakers or Class CC, J, T, G, H, K, L, RK1 or RK5 cartridge fuses or Type S or Edison-base plug fuses are acceptable for the application. Other types of overcurrent protection devices are to be investigated to determine their acceptability for the application.

12.3 effective February 16, 1998

12.4 A TVSS that is provided with fuses that are intended to be replaced in the field shall be marked in accordance with 61.5.

12.4 effective February 16, 1998

12.5 Fuses that are intended to be replaced in the field in a permanently connected TVSS shall be either installed in an extractor type fuse holder or located behind a hinged cover as indicated in 7.1.1.6.

12.5 effective February 16, 1998

12.6 A supplementary protection device shall not be connected in the grounding conductor.

12.6 effective February 16, 1998

12.7 A supplementary protection device shall not open during the Temperature Test in Section 33 or the Measured Limiting Voltage Test in Section 34.

12.7 effective February 16, 1998

12.8 A cord-connected TVSS with four or more receptacle outlets shall be provided with supplementary overcurrent protection as specified in the Standard for Relocatable Power Taps, UL 1363.

12.8 revised December 7, 1999

12.9 A single-pole supplementary protection device shall be connected in the ungrounded (line) conductor of the supply circuit, only. A double-pole device shall be connected on both the ungrounded and grounded (neutral) conductors such that when it operates, it opens both ungrounded and grounded conductors.

12.9 effective February 16, 1998

Table 12.1
Available fault current from source of supply

Table 12.1 revised June 6, 2001

Permanently connected devices ^a		Cord connected or direct plug-in devices ^a		
Rating, A	Available fault current, amperes ^b	Rating volts	Rating, volts times amperes	Available fault current, amperes
100 A or less	5,000	250 ac or less	1175 or less	200
101 – 400 A	10,000		1176 to 1920	1000
Over 400 A	25,000		1921 to 4080	2000
			4081 to 9600	3500
			More than 9600	5000
		More than 250 ac	1920 or less	1000
			More than 1920	5000

^a For one-port TVSS, the rating shall be based on the ampere rating of the circuit that the TVSS is intended to be connected to, in accordance with the manufacturer's instructions. See 60.1.

^b Higher fault current ratings, as detailed in Table 61.2 are able to be used.

13 Accessibility of Live Parts

13.1 The electrical parts of a TVSS that do not require use of a tool to access, shall be so located or enclosed that persons are protected against inadvertent contact with uninsulated current-carrying parts and film-coated magnet wire and accessibility shall be evaluated by performing the accessibility of live parts test in 55A.2.

13.1 revised June 6, 2001

13.2 Deleted June 6, 2001

Figure 13.1
Accessibility probe

Figure 13.1 relocated as Figure 55A.1 June 6, 2001

Figure 13.2
International electrotechnical commission (IEC) rigid accessibility probe

Figure 13.2 relocated as Figure 55A.2 June 6, 2001

14 Supply Connections

14.1 Permanently-connected TVSS

14.1.1 General

14.1.1.1 Supply connections are considered to be those that are made in the field when a device is installed.

14.1.1.1 effective February 16, 1998

14.1.1.2 An outlet box, terminal box, wiring compartment, or the like in which connections to the power-supply circuit are to be made in the field shall be free from sharp edges, including screw threads, burrs, fins, moving parts, or the like, that can damage the insulation on a conductor.

14.1.1.2 effective February 16, 1998

14.1.1.3 A TVSS shall be provided with factory-installed wiring terminals or leads for connection to the power supply.

14.1.1.3 effective February 16, 1998

14.1.1.4 A terminal box or compartment on a fixed device shall be so located that wire connections therein will be accessible for inspection, without disturbing the wiring, after the device is installed in the intended manner.

Exception No. 1: Wire connections to a device intended to be mounted on an outlet box may be accessible upon removal of the device from the outlet box.

Exception No. 2: An electrical component, such as a switch, fuseholder, overcurrent protective device, or the like, may be mounted on a wiring compartment cover provided that:

- a) A component connecting leads are of sufficient length to provide for the making, and examination, of field-wiring connections without placing additional stress on the component wiring terminals,*
- b) Any of the component connections are not to be field wired,*
- c) Strain relief is provided to prevent stress from being transmitted to the component wiring terminations, and comply with the Strain Relief Test, Section 46,*
- d) The minimum size of the component leads is No. 18 AWG (0.82 mm²), and*
- e) Wiring terminals on the component are recessed or protected by barriers of insulating material or the equivalent that will provide protection from contact with wiring installed in the box.*

14.1.1.4 effective February 16, 1998

14.1.1.5 A TVSS provided with integral pigtail leads intended for connection in the field to a power supply circuit conductor shall be provided with a conduit connection means that is acceptable in accordance with the National Electrical Code, ANSI/NFPA-70.

14.1.1.5 effective February 16, 1998

14.1.1.6 An integral pigtail lead intended to be connected in the field to a power supply circuit conductor shall not be smaller than No. 18 AWG (0.82 mm²) and shall not be shorter than 152 mm (6 inches), when measured from the point of exit from the conduit connector. Insulation on such a lead shall be:

- a) At least 0.8 mm (1/32 inch) thick thermoplastic; or
- b) At least 0.4 mm (1/64 inch) thick rubber plus a braid cover for 300 V or less applications; or
- c) At least 0.8 mm (1/32 inch) thick rubber plus a braid cover for applications between 301 and 600 V.

14.1.1.6 effective February 16, 1998

14.1.1.7 A pigtail lead, described in 14.1.1.5 shall comply with the Conductor Secureness Test, Section 48.

14.1.1.7 effective February 16, 1998

14.1.1.8 A permanently-connected TVSS shall have a field-wiring terminal, wiring lead, conduit fitting, a knockout or other opening in the enclosure and wire bending space, for the connection of a wiring system in accordance with the National Electrical Code, ANSI/NFPA-70 and acceptable for the purpose.

Exception: An enclosure need not have provision for the connection of a wiring system, such as a conduit hub, a knockout or a fitting, if it is intended to be drilled or punched in the field to accommodate a wiring system and is provided with appropriate installation instructions.

14.1.1.8 effective February 16, 1998

14.1.1.9 A TVSS that is acceptable for use with a fitting for only one type of wiring system shall be supplied with such a fitting. Installation instructions shall be provided if use of the fitting is not explicit.

14.1.1.9 effective February 16, 1998

14.1.1.10 If a lead intended for field connection to the supply circuit terminates at an accessible terminal screw, the terminal screw shall be staked, soldered, or otherwise rendered non-removable.

14.1.1.10 effective February 16, 1998

14.1.2 Terminals

14.1.2.1 Terminal parts to which supply connections are to be made shall be acceptable for connection of conductors to ensure a thoroughly good connection without damaging the conductors. Some examples are pressure connectors (including set-screw type), solder lugs, or splices to flexible leads.

14.1.2.1 revised March 8, 2000

14.1.2.2 Pressure wire connectors or solder lugs shall be used.

Exception: For a No. 10 AWG (5.3 mm²) or smaller wire, the parts to which wiring connections are to be made may consist of clamps or binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position.

14.1.2.2 effective February 16, 1998

14.1.2.3 A wire-binding screw employed at a wiring terminal shall not be smaller than No. 8 (4.2 mm diameter), except that a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 14 AWG (2.2 mm²) conductor.

14.1.2.3 effective February 16, 1998

14.1.2.4 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.76 mm (0.030 inch) thick and there shall not be less than two full threads in the metal.

14.1.2.4 effective February 16, 1998

14.1.2.5 A wire-binding screw shall thread into metal.

14.1.2.5 effective February 16, 1998

14.1.2.6 A field-wiring terminal intended for the connection of a grounded conductor shall be substantially white in color and shall be easily distinguishable from the other terminals, or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram. If wire leads are provided instead of terminals, the surface of the grounded conductor shall be finished to show white or natural grey color and shall be easily distinguishable from the other leads.

14.1.2.6 effective February 16, 1998

14.1.2.7 In order to polarize the wiring of a permanently-wired device intended to be connected to a supply circuit rated at 125 V or 125/250 V or less, and employing an overcurrent-protective device other than an automatic control, one terminal or lead shall be identified for the connection of the grounded conductor of the supply circuit. See 14.1.2.6 for identification requirements. The grounded conductor or a terminal identified for this use shall be the one to which no overcurrent-protective devices of the single-pole type is connected.

14.1.2.7 effective February 16, 1998

14.2 Cord-connected TVSS

14.2.1 General

14.2.1.1 A metal strain-relief clamp or band without auxiliary protection is acceptable with a Type SJ, SJO, SJT, SJTO, SO, ST, STO, or equivalent cord. A metal strain-relief clamp or band is acceptable with a Type SP-3, SPT-3 or equivalent cord only if acceptable auxiliary mechanical protection that is not electrically conductive is provided over the cord.

14.2.1.1 effective February 16, 1998

14.2.1.2 The flexible cord shall be Type S, SO, ST, SJ, STO, SJO, SJT, SJTO or shall be a type at least as serviceable for the particular application.

Exception: SPT-3 or SP-3 may be used on a TVSS rated 15 A, or less, if marked in accordance with 61.13.

14.2.1.2 revised December 7, 1999

14.2.1.2.1 A cord set shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817.

14.2.1.2.1 added June 6, 2001

14.2.1.3 The supply cord shall have a voltage rating not less than the rated voltage of the TVSS, and shall have an ampacity not less than the current rating of the TVSS. The power-supply cord of a cord-connected TVSS must also comply with the power-supply cord gauge requirements in the Standard for Relocatable Power Taps, UL 1363.

Exception: A TVSS employing one or two receptacles is not prohibited from having a smaller ampacity supply cord when the cord ampacity complies with the:

a) Table for Allowable Ampacity for Flexible Cords and Cables in the National Electrical Code, ANSI/NFPA 70;

b) Temperature Test, Section 33;

c) Fault Current Test, Section 39; and

d) Overcurrent Test, Section 40.

14.2.1.3 revised June 6, 2001

14.2.1.4 The length of a supply cord measured from the outside surface of the enclosure of a TVSS to the plane of the face of the attachment plug shall not be less than 0.45 m (1.5 ft) or be more than 7.6 m (25 ft.).

Exception: TVSS with only one or two receptacles are not required to comply with the minimum supply cord length.

14.2.1.4 revised November 15, 2001

14.2.1.4.1 For a TVSS employing an outlet cord as described in 16.1, the total length of the outlet cord including the receptacle shall not be more than 1.8 m (6 ft). The total length of a supply cord, measured from inlet to outlet including the body of the TVSS, shall not be more than 7.6 m (25 feet).

14.2.1.4.1 added June 6, 2001

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