



UL 756

STANDARD FOR SAFETY

Coin and Currency Changers and Actuators

[ULNORM.COM](https://www.ulnorm.com) : Click to view the full PDF of UL 756 2018

ULNORM.COM : Click to view the full PDF of UL 756 2018

Coin and Currency Changers and Actuators, UL 756

Eighth Edition, Dated August 25, 2016

Summary Of Topics

This revision of UL 756, dated October 2, 2018, was issued to include the following changes in requirements:

Revisions To Update Requirements For Controls

Addition Of And Revisions To Requirements To Address Switch Mode Power Supply Units Increasingly Used In Coin And Currency Changers and Actuators

Addition Of Requirements To Clarify Requirements Applicable To Accessories

Additions Of Requirements To Clarify Requirements Applicable To Products Used In Protected Locations

Revisions To Marking Requirements To Clarify Application Of UL 969 Requirements

Revisions To EMI Filter Requirements To Specify An Alternate Compliance Option

Revisions To Leakage Current Test Requirements To Allow Higher Leakage Current For Products That Require Electromagnetic Interference Suppression

Revisions To Incorporate Editorial Corrections

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.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 29, 2018.

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.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 756 2018

AUGUST 25, 2016

(Title Page Reprinted: October 2, 2018)

1

UL 756

Standard for Coin and Currency Changers and Actuators

First Edition – April, 1979
Second Edition – February, 1982
Third Edition – October, 1987
Fourth Edition – April, 1993
Fifth Edition – August, 1997
Sixth Edition – March, 2010
Seventh Edition September, 2012

Eighth Edition

August 25, 2016

This UL Standard for Safety consists of the Eighth Edition including revisions through October 2, 2018.

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 <https://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 © 2018 UNDERWRITERS LABORATORIES INC.

ULNORM.COM : Online viewing the full PDF of UL 756 2018

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 756 2018

CONTENTS

INTRODUCTION

1 Scope	4
2 Glossary	4
3 Units Of Measurement	10
4 References	10

CONSTRUCTION

5 General	10E
6 Barriers	10F
7 Frame And Enclosure	11
7.1 General	11
7.2 Doors and covers	11
7.3 Cast metal	12
7.4 Sheet metal	12
7.5 Gaskets and adhesives	15
7.6 Nonmetallic Parts	15
7.7 Nonmetallic Materials	15
7.8 Nonmetallic Material Ignition Sources Separation	16
7.9 Nonmetallic Material Application and Location	17
7.10 Glass-covered openings	17
7.11 Wiring openings	17
7.12 Enclosures for outdoor use	18
8 Mounting	19
9 Mechanical Assembly	19
10 Protection Against Corrosion	20
10.1 General	20
10.2 Outdoor use	20
11 Accessibility Of Uninsulated Live Parts, Film-Coated Wire, And Moving Parts	22
12 Supply Connections	28
12.1 General	28
12.2 Permanently connected	29
12.3 Terminals	29
12.4 Leads	31
12.5 Cord-connected	31
13 Grounding	33
14 Internal Wiring	36
15 Splices and Connections	38
16 Separation of Circuits	40

SPACINGS

17 High-Voltage Circuits	41
18 Low-Voltage Circuits	44
19 Isolated, Power-Limited Circuits	44
20 Electronic Circuits	45
21 Alternate Spacings – Clearances and Creepage Distances	45

ELECTRICAL COMPONENTS

22	Motors	46
23	Overcurrent Protection	46
23.1	General	46
23.2	Motors	47
24	Live Parts	49
25	Insulating Materials	50
26	Switches and Controllers	50
27	Remotely Operated Appliances	56
28	Coil Windings	57
29	Transformers	57
30	Capacitors	57
31	Printed Wiring	59
32	Receptacles	60
33	Field Installation	61
34	Batteries and Battery Chargers	62
35	Connectors	62
36	Electrical Cable, Conduit and Tubing	62
37	Electromagnetic Interference Filters	62
38	Fuseholders	62
39	Heating Elements	63
40	Lighting Systems	63
40.1	General	63
40.2	Electric-Discharge Lighting Systems	63
41	Optical Isolators and Semiconductor Devices	65
42	Outlet Boxes, Fittings and Cover Plates	65
43	Power Supplies	65
44	Terminal Blocks	66
45	Wireways, Auxiliary Gutters and Associated Fittings	66
46	Information Technology Equipment	66

PROTECTION AGAINST RISK OF INJURY TO PERSONS

47	Scope	66
48	General	67
49	Sharp Edges	67
50	Surface Temperatures	67
51	Stability Test	68
52	Switches and Controllers	69
53	Cover or Door	69
54	Risk of Injury to Service Person	69

PERFORMANCE

55	General	69
56	Input Test	70
57	Leakage Current Test	70A
58	Normal Temperature Test	73
59	Dielectric Voltage-Withstand Test	77
60	Overtoltage and Undervoltage Test	78
61	Volt-Ampere Capacity Test	78
62	Power-Limited Circuits	79
62.1	General	79
62.2	Maximum voltage	82

62.3	Maximum current	82
62.4	VA _{max} (Not inherently limited circuits only)	82
63	Abnormal Operation Tests	83
63.1	General	83
63.2	Currency rejection	83
63.3	Solenoid burnout	83
63.4	Transformer burnout	84
63A	Switch Mode Power Supply Units – Overload Test	84
64	Flexing of Internal Wiring Test	84A
65	Strain Relief Test	84A
66	Accelerated Aging on Gaskets, Sealing Compounds, and Adhesives	84A
67	Tests on Nonmetallic Materials	85
68	Fastener Strength Test	88
69	Resistance to Moisture Test	89
70	Permanence of Marking Test	92
71	Metallic-Coating-Thickness Test	93
72	Bonding Conductor Test	94
73	Electronic Circuits Test	96
74	Overload and Endurance Test – Switching Devices	96
75	Protective Electronic Circuit Tests	98
75.1	General	98
75.2	Fault conditions abnormal test	98
75.3	Electromagnetic compatibility (EMC) tests	99
75.4	Programmable component reduced supply voltage test	101
75.5	Fuse-link test	102

MANUFACTURING AND PRODUCTION TESTS

76	Dielectric Voltage-Withstand Test	103
77	Grounding Continuity Test	104
78	Protective Electronic Circuit Test	104A

MARKING

79	General	104A
80	Cautionary Marking	107

APPENDIX A – Operating and protective (“safety critical”) control functions (Normative)

INTRODUCTION

1 Scope

1.1 These requirements cover self-contained coin, credit card, debit card, currency, and token changers and actuators rated not more than 600 volts for use in accordance with ANSI/NFPA 70.

1.2 These requirements cover open-type appliances intended to be factory or field installed in vending machines and other appliances.

1.3 These requirements cover open-type controls for use with coin, credit card, debit card, currency, and token-operated devices intended to be factory installed within vending machines and other appliances.

1.4 These requirements do not cover the effectiveness of antitheft protection features.

1.5 Battery operated coin and currency changers and actuators are covered by these requirements.

2 Glossary

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

2.1.1 **ACCESSORY** – A device or component intended for installation in or connection to a product for the purpose of modifying or supplementing the functions of the product. It is intended for installation by the serviceman or another equally qualified person in the field. An accessory relies upon the product for electrical power, signaling, switching, or the like.

2.2 **ADJUSTABLE SPEED DRIVE** – A combination of power converter, inverter, motor, and motor-mounted auxiliary devices such as encoders, tachometers, thermal switches and detectors, air blowers, heaters, and vibration sensors.

2.3 **ADJUSTABLE SPEED DRIVE SYSTEM** – An interconnected combination of equipment that provides a means of adjusting the speed of a mechanical load coupled to a motor. A drive system typically consists of an adjustable speed drive and auxiliary electrical apparatus.

2.4 **APPLIANCE** – Denotes all coin, credit card, debit card, currency, and token changers and actuators included in the scope of this standard. A requirement that applies only to specific equipment is identified by a specific reference in that requirement to the equipment involved.

2.5 **BARRIER** – A partition for isolating high-voltage electrical components, separating ignition sources from flammable materials, isolating moving parts and protection of wiring.

2.6 **CABINET** – The part of the equipment that provides physical protection to insulated wiring, enclosures, moving parts, motors, enclosed electrical parts, tubing or other parts that may cause injury to persons.

2.6.1 **CAPACITOR, CLASS Y** – Capacitor or resistor-capacitor unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock. (Examples would include capacitors connected across the primary and secondary circuits where electrical isolation is required to prevent an electric shock or between hazardous live parts and accessible parts.)

2.7 CIRCUITS, ELECTRICAL –

- a) High-Voltage (Class 1) – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage power-limited circuit.
- b) Low-Voltage – A circuit involving a potential of not more than 30 volts AC rms, 42.4 volts DC or AC peak.
- c) Power-Limited – A circuit whose output is limited as specified in Power-Limited Circuits, Section 62.

ULNORM.COM : Click to view the full PDF of UL 756 2018

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 756 2018

d) Class 2 – A circuit in which the voltage and power limitations are in accordance with the Class 2 requirements of Table 62.1 for AC circuits and Table 62.2 for DC circuits.

e) Class 3 – A circuit in which the voltage and power limitations are in accordance with the Class 3 requirements of Table 62.1 for AC circuits and Table 62.2 for DC circuits.

2.8 COMPONENT – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to that purpose. If incorporated in an appliance, a product that is 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 aluminum or copper, are not considered components. Generally, components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under specific, limited conditions, such as certain temperatures not exceeding specified limits.

2.9 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the risk of electric shock, is considered an operating control. Operating controls are also referred to as “regulating controls”. Appendix A, Operating and Protective (Safety Critical) Control Functions, specifies control functions that are not considered to result in a risk of fire, electric shock, or injury to persons.

2.10 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of fire, electric shock, or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as “limiting controls” or “safety controls” and are investigated under normal and single-fault conditions. Appendix A specifies control functions that are considered to result in a risk of fire, electric shock, or injury to persons.

2.11 ELECTRONIC COMPONENT – A part in which electrical conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor. A metal oxide varistor (MOV) is considered to be an electronic component, but neon indicators are not.

©IEC This definition is reproduced from IEC 60335-1, Ed. 5.1 b:2013 with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission. All rights reserved.

2.12 ELECTRONIC DISCONNECTION – The de-energizing of a load within an appliance by an electronic device of a circuit. No electro-mechanical component having an air gap, such as a switch, contactor or relay is used to de-energize the load.

©IEC This definition is reproduced from IEC 60335-1, Ed. 5.1 b:2013 with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission. All rights reserved.

2.13 ENCLOSURE – The part of the appliance that does one or more of the following:

- a) Isolates ignition sources;
- b) Renders inaccessible all or any part(s) of the equipment that may otherwise present a risk of electric shock;
- c) Retards propagation of flame initiated by electrical disturbances occurring within.

2.14 FUNCTIONAL PART – A part other than an enclosure or cabinet used to maintain the intended relative physical position of fixed or moving parts, or maintain the integrity of the structure.

2.15 GROUNDING, FUNCTIONAL – Grounding of a point in an appliance which is necessary for a purpose other than safety.

2.16 IGNITION SOURCE – Any high-voltage electrical component not located within an enclosure.

2.17 MAXIMUM OPERATING CURRENT (MOC) – The current resulting when an electric motor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor/adjustable speed drive or drive system is at a maximum.

2.18 MOTOR CONTROLLER – Any device normally used to start and stop a motor, such as a switch, thermostat, pressure limiting control, or the like.

2.19 MOTOR, DIRECTLY ACCESSIBLE – A motor that can be contacted without opening or removing any part, or that is located so as to be accessible to contact.

2.20 MOTOR, INDIRECTLY ACCESSIBLE – A motor that is accessible only by opening or removing a part of the cabinet, such as a guard or panel that can be opened or removed without using a tool, or that is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

2.21 NONFUNCTIONAL PART – A part of the equipment that does not perform a specific function.

2.22 NONFUNCTIONAL PART, SMALL – A nonfunctional part having an area of less than 1 ft²(0.093 m²) located so it cannot propagate flame from one area to another, and does not connect a possible source of ignition to the other ignitable parts.

2.23 OPEN-TYPE CONTROL – Controls and devices that are incomplete in certain construction features and need to be installed within another appliance.

2.24 OPERATOR OR USER SERVICING – Any form of servicing that might be performed by personnel other than qualified service personnel. Some examples are:

- a) The attachment of accessories by means of attachment plugs and receptacles or by means of other separable connectors.
- b) Resetting or replacement of circuit breakers, tubes, fuses, and lamps that are accessible without the use of tools.
- c) Making routine operating adjustments necessary to adapt the appliance for its different intended functions.
- d) Routine cleaning, removal of coins, price changing, replenishing the product supply, making minor adjustments, and other services performed by the route man who regularly opens an appliance for such purposes.

2.24.1 OUTDOOR LOCATION – In the open and subjected to the full effects of weathering.

2.24.2 PROTECTED LOCATION – In an area that is partially protected from the effects of weathering through the use of a roof, canopy, marquee, or the like.

2.25 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a risk of fire, electric shock or injury to persons under abnormal operating conditions.

©IEC This definition is reproduced from IEC 60335-1, Ed. 5.1 b:2013 with permission of the American National Standards Institute (ANSI) on behalf of the International Electrotechnical Commission. All rights reserved.

2.26 ROUTE PERSON – A person who regularly opens an appliance for such purposes as cleaning, removing coins, making minor adjustments and replenishing the product supply.

2.27 SELF-CONTAINED APPLIANCE – Coin, credit card, debit card, currency, and token changers and actuators that are complete in their construction.

2.28 SERVICE PERSON – A person who may periodically open an appliance to repair or maintain electrical or mechanical components.

2.28.1 SWITCH MODE POWER SUPPLY UNIT – Electronic device incorporating transformer(s) and electronic circuitry(ies), that converts electrical power into single or multiple power outputs by rapidly switching a solid-state device on and off. It may also isolate the input circuit from the output circuit and regulate and/or convert the output voltage and current. The device may consist of one or more individual units with identical or different waveforms and frequencies including dc output.

2.29 THERMISTOR – A thermally sensitive semiconductor resistor, which shows over at least part of its resistance/temperature characteristic a significant non-linear change in its electrical resistance with a change in temperature. A thermistor may be either of the positive temperature coefficient (PTC) type or of the negative temperature coefficient (NTC) type.

2.30 VOLTAGE FOLDBACK – A circuit design feature intended to protect the power supply output transistors. When overcurrent is drawn by the load, the supply reduces the output voltage and current to within the safe power dissipation limit of the output transistors.

ULNORM.COM - Click to view the full PDF of UL 756 2018

3 Units Of Measurement

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

4 References

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

ANSI Standards

ANSI Z97.1, *Safety Glazing Materials Used In Buildings – Safety Performance Specifications And Methods Of Test*

ASTM Standards

ASTM D412, *Standard Test Methods for Vulcanized Rubber, and Thermoplastic Rubber and Thermoplastic Elastomers – Tension*

ASTM A90/A90M, *Test Method of the Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings*

ASTM A90/A90M-95a, *Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings*

ASTM A653/A653M, *Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

ASTM E28, *Standard Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-and-Ball Apparatus*

ASTM E162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

IEC Standards

IEC 60127-1, *Miniature Fuses: Part 1, Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields*

IEC 61000-4-11, *Electromagnetic Compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests*

IEC 61000-4-13, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signalling at a.c. Power Port, Low Frequency Immunity Tests*

IEC 61000-4-34, *Electromagnetic Compatibility (EMC) – Part 4-34: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Input Current More Than 16 A Per Phase*

NEMA Standards

NEMA WD6, *Wiring Devices – Dimensional Requirements*

NFPA Standards

ANSI/NFPA 70, *National Electrical Code*

UL Standards

UL 1, *Flexible Metal Conduit*

UL 4, *Armored Cable*

UL 6, *Rigid Metal Conduit – Steel*

UL 20, *General-Use Snap Switches*

UL 44, *Thermoset-Insulated Wires and Cables*

UL 62, *Flexible Cords and Cables*

UL 83, *Thermoplastic-Insulated Wires and Cables*

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

UL 157, *Gasket and Seals*

UL 224, *Extruded Insulating Tubing*

UL 244A, *Solid-State Controls for Appliances*

UL 248-1, *Standard for Low-Voltage Fuses – Part 1: General Requirements*

UL 248-4, *Low-Voltage Fuses – Part 4: Class CC Fuses*

UL 248-5, *Low-Voltage Fuses – Part 5: Class CC Fuses*

UL 248-8, *Low-Voltage Fuses – Part 8: Class J Fuses*

UL 248-9, *Low-Voltage Fuses – Part 9: Class K Fuses*

UL 248-10, *Low-Voltage Fuses – Part 10: Class L Fuses*

UL 248-11, *Low-Voltage Fuses – Part 11: Plug Fuses*

UL 248-12, *Low-Voltage Fuses – Part 12: Class R Fuses*

UL 248-14, *Low-Voltage Fuses – Part 14: Supplemental Fuses*

UL 248-15, *Low-Voltage Fuses – Part 15: Class T Fuses*

UL 310, *Electrical Quick-Connect Terminals*

UL 486A-486B, *Wire Connectors*

UL 486C, *Splicing Wire Connectors*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures*

UL 489A, *Circuit Breakers For Use in Communications Equipment*

UL 496, *Lampholders*

UL 498, *Attachment Plugs and Receptacles*

UL 499, *Electric Heating Appliances*

UL 508, *Industrial Control Equipment*

UL 508C, *Power Conversion Equipment*

UL 510, *Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape*

UL 514A, *Metallic Outlet Boxes*

UL 514B, *Conduit, Tubing, and Cable Fittings*

UL 514C, *Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers*

UL 514D, *Cover Plates for Flush-Mounted Wiring Devices*

UL 542, *Fluorescent Lamp Starters*

UL 635, *Insulating Bushings*

UL 719, *Nonmetallic Sheathed Cables*

UL 723, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

- UL 746B, *Polymeric Materials – Long Term Property Evaluations*
- UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*
- UL 746E, *Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards*
- UL 758, *Appliance Wiring Material*
- UL 796, *Printed-Wiring Boards*
- UL 797, *Electrical Metallic Tubing – Steel*
- UL 810, *Capacitors*
- UL 817, *Cord Sets and Power Supply Cords*
- UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*
- UL 870, *Wireways, Auxiliary Gutters and Associated Fittings*
- UL 917, *Clock-Operated Switches*
- UL 935, *Fluorescent-Lamp Ballasts*
- UL 969, *Marking and Labeling Systems*
- UL 1004-2, *Impedance Protected Motors*
- UL 1004-3, *Thermally Protected Motors*
- UL 1004-7, *Electronically Protected Motors*
- UL 1012, *Power Units Other Than Class 2*
- UL 1029, *High-Intensity-Discharge Lamp Ballasts*
- UL 1030, *Sheathed Heating Elements*
- UL 1059, *Terminal Blocks*
- UL 1077, *Supplementary Protectors for Use in Electrical Equipment*
- UL 1283, *Electromagnetic Interference Filters*
- UL 1310, *Class 2 Power Units*
- UL 1412, *Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances*
- UL 1434, *Thermistor-Type Devices*
- UL 1439, *Test for Sharpness of Edges on Equipment*

UL 1441, *Coated Electrical Sleeving*

UL 1446, *Insulating Materials – General*

UL 1449, *Surge Protective Devices*

UL 1565, *Positioning Devices*

UL 1577, *Optical Isolators*

UL 1642, *Lithium Batteries*

UL 1977, *Component Connectors for Data, Signal, Control and Power Applications*

UL 2054, *Household and Commercial Batteries*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-4, *Fuseholders – Part 4: Class CC*

UL 4248-5, *Fuseholders – Part 5: Class G*

UL 4248-8, *Fuseholders – Part 8: Class J*

UL 4248-9, *Fuseholders – Part 9: Class K*

UL 4248-11, *Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse*

UL 4248-12, *Fuseholders – Part 12: Class R*

UL 4248-15, *Fuseholders – Part 15: Class T*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-2, *Low Voltage Transformers – Part 2: General Purpose Transformers*

UL 5085-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

UL 60065, *Audio, Video and Similar Electronic Apparatus – Safety Requirements*

UL 8750, *Light Emitting Diode (LED) Equipment For Use in Lighting Products*

UL 60335-1, *Household and Similar Electrical Appliances, Part 1: General Requirements*

UL 60384-14, *Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains*

UL 60691, *Thermal-Links – Requirements and Application Guide*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-6, *Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements*

UL 60730-2-9, *Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls*

UL 60939-3, *Passive Filter Units for Electromagnetic Interference Suppression – Part 3: Passive Filter Units for Which Safety Tests are Appropriate*

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

UL 61058-1, *Switches for Appliances – Part 1 General Requirements*

CONSTRUCTION

5 General

5.1 An appliance shall employ materials found by investigation to be acceptable for the use, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

5.2 A component shall:

- a) Comply with the safety standard covering that component;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability; and
- d) Comply with the applicable requirements of this end product standard.

Exception: 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;*
- b) Is superseded by a requirement in this standard; or*
- c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.*

5.3 A component that is also required to perform other necessary functions, such as overcurrent 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) covering products that provide those functions.

6 Barriers

6.1 A barrier shall be formed from one or more of the following:

- a) Metal, minimum 0.005 inch (0.13 mm) thick;
- b) Fiberglass, minimum 0.5 inch (12.7 mm) thick;
- c) A nonmetallic material rated 5 volt-ampere;
- d) A nonmetallic material evaluated to the 127 mm (5 inch) End Product Flame Test as described in UL 746C;
- e) Vulcanized fiber, varnished cloth, mica or phenolic composition, minimum 0.028 inch (0.71 mm) thick; or
- f) Any other material or construction determined to be equivalent to items (a) to (e).

6.2 A barrier shall be secured to the mounting surface such that tools are required for its removal.

6.3 Except as specified in 6.5 and 13.2, a nonmetallic barrier that isolates ignition source(s) shall comply with the enclosure requirements of Table 67.1.

6.4 A nonmetallic barrier providing mechanical protection shall comply with the cabinet requirements of Table 67.1.

6.5 If a barrier made of the materials specified 6.1(e) but less than 0.028 inch (0.71 mm) thick is used, the:

- a) Air spacing between the parts being insulated by the barrier shall be not less than one-half of the required through-air spacing; and
- b) Barrier shall be not less than 0.013 inch (0.3 mm) thick.

7 Frame And Enclosure

7.1 General

7.1.1 An appliance shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

7.1.2 Electrical parts of an appliance, other than a supply cord or low-voltage terminals – see 18.1 – shall be located or enclosed so that protection against unintentional contact with uninsulated live parts will be provided. See 11.1.

Exception: An enclosure is not required for an appliance designed for assembly as part of another appliance.

7.1.3 The frame or chassis of an appliance shall not be relied upon to carry current during normal operation.

Exception: As provided in 13.5.

7.1.4 A part such as a dial or nameplate that is, in effect, a part of the enclosure shall comply with the requirements in 7.3.1, 7.4.1, or 7.6.1.

7.2 Doors and covers

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

Exception: A hinged cover and the construction described in 7.2.2 – 7.2.4 are not required for an appliance in which the only fuses enclosed are an extractor-type fuse with its own enclosure, or fuses in low-voltage circuits. See 18.1.

7.2.2 A door or cover giving access to a fuse or thermal cutout in other than a low-voltage circuit – see 18.1 – shall shut closely against a 1/4-inch (6.3-mm) 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 proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A construction that affords equivalent protection, or a combination of flange and rabbet that has been investigated and found to be acceptable, may be used.

7.2.3 Strips used to provide rabbets, or angle strips fastened to the edges of a door shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

7.2.4 A hinged cover shall be provided with a spring latch or catch.

Exception: For a hinged cover that is provided, although not required, a hasp, sliding latch, or other means for holding the cover closed may be employed.

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

7.2.6 Sheet-metal screws threading directly into metal shall not be used to attach a cover, a door, or other part that is 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, and machine screws and self-tapping machine screws may thread directly into sheet-metal walls.

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

7.3 Cast metal

7.3.1 Cast metal for an enclosure shall not be less than 1/8 inch (3.2 mm) thick at every point, of greater thickness at reinforcing ribs and door edges, and not less than 1/4 inch (6.3 mm) thick at tapped holes for conduit, except that, other than at plain or threaded conduit holes, die-cast metal shall not be less than 3/32 inch (2.4 mm) thick for an area greater than 24 square inches (155 cm²) or having any dimension greater than 6 inches (152 mm), and shall not be less than 1/16 inch (1.6 mm) thick for an area of 24 square inches or less and having no dimension greater than 6 inches. The area limitation for metal 1/16 inch thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

Exception No. 1: Die-cast metal not less than 0.035 inch (0.89 mm) thick may be employed if the enclosure will not be used as a splice box and if the voltage rating of the complete appliance is such that the voltage between any two conductors is 250 volts or less and is limited to direct current or single-phase alternating current.

Exception No. 2: Die-cast metal not less than 0.028 inch (0.71 mm) thick may be employed for an enclosure housing only low-voltage circuits as defined in 18.1.

7.4 Sheet metal

7.4.1 Unless investigated and found acceptable for the application, the thickness of a sheet-metal enclosure shall not be less than that specified in Tables 7.1 and 7.2.

Exception: Uncoated steel shall not be less than 0.032 inch (0.81 mm) thick, zinc-coated steel shall not be less than 0.034 inch (0.86 mm) thick, and nonferrous metal shall not be less than 0.045 inch (1.14 mm) thick at points at which a wiring system is to be connected.

7.4.2 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.

7.4.3 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 rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has the torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels.

7.4.4 With reference to 7.4.3 and Tables 7.1 and 7.2, a construction is not considered to have a supporting frame if it is:

- a) A single sheet with single formed flanges – formed edges;
- b) A single sheet that is corrugated or ribbed;
- c) An enclosure formed or fabricated from sheet metal; or
- d) An enclosure surface loosely attached to a frame, for example, by spring clips.

Table 7.1
Thickness of sheet metal for enclosures, carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness	
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, inches (cm)	Uncoated, inch (mm)	Metal coated, inch (mm)
4.0 (10.2)	Not limited	6.25 (15.9)	Not limited		0.023 ^d (0.58)
4.75 (12.10)	5.75 (14.6)	6.75 (17.1)	8.25 (21.0)	0.020 ^d (0.51)	
6.0 (15.2)	Not limited	9.5 (24.1)	Not limited		0.029 ^d (0.74)
7.0 (17.8)	8.75 (22.2)	10.0 (25.4)	12.5 (31.8)	0.026 ^d (0.66)	
8.0 (20.3)	Not limited	12.0 (30.5)	Not limited		0.034 (0.86)
9.0 (22.9)	11.5 (29.2)	13.0 (33.0)	16.0 (40.6)	0.032 (0.81)	
12.5 (31.8)	Not limited	19.5 (49.5)	Not limited		0.045 (1.14)
14.0 (35.6)	18.0 (45.7)	21.0 (53.3)	25.0 (63.5)	0.042 (1.07)	
18.0 (45.7)	Not limited	27.0 (68.6)	Not limited		0.056 (1.42)
20.0 (50.8)	25.0 (63.5)	29.0 (73.7)	36.0 (91.4)	0.053 (1.35)	
22.0 (55.9)	Not limited	33.0 (83.8)	Not limited		0.063 (1.60)
25.0 (63.5)	31.0 (78.7)	35.0 (88.9)	43.0 (109.2)	0.060 (1.52)	
25.0 (63.5)	Not limited	39.0 (99.2)	Not limited		0.070 (1.78)
29.0 (73.7)	36.0 (91.4)	41.0 (104.1)	51.0 (129.5)	0.067 (1.70)	
33.0 (83.8)	Not limited	51.0 (129.5)	Not limited		0.084 (2.13)
38.0 (103.4)	47.0 (119.4)	54.0 (137.2)	66.0 (167.6)	0.080 (2.03)	
42.0 (106.7)	Not limited	64.0 (162.6)	Not limited		0.097 (2.46)
47.0 (119.4)	59.0 (149.9)	68.0 (172.7)	84.0 (213.4)	0.093 (2.36)	
52.0 (132.1)	Not limited	80.0 (203.2)	Not limited		0.111 (2.82)
60.0 (152.4)	74.0 (188.0)	84.0 (213.4)	103.0 (261.6)	0.108 (2.74)	
63.0 (160.0)	Not limited	97.0 (246.4)	Not limited		0.126 (3.20)
73.0 (185.4)	90.0 (228.6)	103.0 (261.6)	127.0 (322.6)	0.123 (3.12)	

^a See 7.4.3 and 7.4.4.

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

Table 7.1 Continued on Next Page