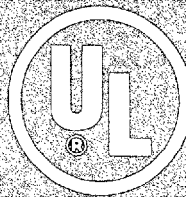


Standard for Safety

UL 1023

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Household Burglar-Alarm System Units



Underwriters Laboratories Inc.®

Standard



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for
Household Burglar-Alarm System Units, UL 1023

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No Text on This Page

CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	7
2 General	7
3 Glossary	8
4 Instructions and Drawings	10

CONSTRUCTION**ASSEMBLY**

5 General	10
6 Test Features	11
7 Enclosures	11
8 Electric Shock	20
9 Protection Against Corrosion	21

FIELD WIRING CONNECTIONS

10 General	21
11 Cord-Connected Products	21
12 Permanently Connected Products	22
13 Special Terminal Assemblies	24
14 Polarity Identification	25

INTERNAL WIRING AND ASSEMBLY

15 General	25
16 Separation of Circuits	25
17 Bonding for Grounding	26
18 Equipment Grounding Connection	27

ELECTRICAL COMPONENTS

19 General	28
20 Insulating Materials	29
21 Batteries	30
22 Lampholders and Lamps	31
23 Transformers, Coils, and Relays	31

SPACINGS

24 General	31
------------------	----

PERFORMANCE**GENERAL**

25 Common Requirements	33
------------------------------	----

26	Operation Test	34
27	Electrical Supervision Test	36
28	Input Test	36
29	Power-Limited Circuits	37
30	Undervoltage Operation Test	41
31	Overvoltage Operation Test	41
32	Variable Ambient Temperature Test	41
33	Humidity Test	42
34	Leakage Current Test for Cord-Connected Products	42
35	Electric Shock Current Test	44
36	Overload Test	47
37	Endurance Test	49
38	Jarring Test	49
39	Vibration Test	50
40	Dust Test	50
41	Component Malfunction Test	51
42	Rain Test	51
43	Dielectric Voltage-Withstand Test	54
44	Static Discharge Test	55
45	Temperature Test	55
46	Charging Current Test	59
47	Abnormal Operation Test	60
48	Electrical Transient Tests	60
49	AC Induction Test	63
50	Tests on Polymeric Materials	63
51	Audibility Test	64
52	Battery Replacement Test	64
53	Drop Test	64
54	Strain Relief Test	65
55	Ignition Through Bottom-Panel Openings Tests	65
56	Mechanical Strength Tests for Enclosures	66
57	Special Terminal Assemblies Tests	67

SHORT RANGE RADIO FREQUENCY DEVICES

58	General	68
59	Reference Level Determination	68
60	Interference Immunity	73
61	Frequency Selectivity	74
62	Time to Report Alarm	75
63	Inoperative Transmitter Reporting	75
64	Clash	76
65	Error (Falsing) Rate	76
66	Throughput Rate	78
67	Maximum Duration of Transmission	79
68	Battery Status Indication	79
69	Transmitter Stability Tests	79
70	Transmitter Accelerated Aging Test	80
71	Installation Instructions and User Manual	80

SHORT RANGE WIRELESS DEVICES

72	General	80
73	Time to Report Alarm	80

74	Inoperative Transmitter Reporting	80
75	Clash	81
76	Error (Falsing) Rate	81
77	Throughput Rate	82
78	Maximum Duration of Transmission	83
79	Battery Status Indication	83
80	Transmitter Stability Tests	83
81	Transmitter Accelerated Aging Test	83
82	Installation Instructions and User Manual	83

MANUFACTURING AND PRODUCTION TESTS

83	General	84
84	Dielectric Voltage-Withstand Tests	84
85	Grounding Continuity Tests for Cord-Connected Products	85

MARKINGS

86	Details	85
----	---------------	----

ACCESSORY EQUIPMENT

87	General	88
88	Construction	88
89	Performance (Installation) Test	88
90	Markings	88

APPENDIX A

Standards for Components	A1
--------------------------------	----

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 employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the 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 burglar-alarm system units intended for use in residences to protect a complete multiroom residence, one room of a residence, or one opening or area in a residence.

1.2 Household burglar-alarm system units covered by these requirements consist of one or more unit assemblies of electrical components that are designed to detect the presence, movement, sound, or other activity of an intruder. Provisions are made for the connection of a power supply, remote control, and signal circuits by a prescribed method of wiring. These system units usually operate within the limits of Class 2 remote control and signal circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

1.3 These requirements also apply to the use of combination systems, such as a combination fire-burglar-alarm system control unit. A combination system is connected in such a manner that fault conditions (shorts, opens, grounds) in the burglar-alarm system circuit wiring, or interconnections between the fire- and burglar-alarm system circuits, will not interfere with the supervision of the fire alarm system or will not prevent intended alarm signal operation.

1.4 These requirements cover accessories that are external to the control unit and that are dependent upon the control unit function, such as end-of-line devices, annunciators, remote switches, and the like.

1.5 Intrusion detection devices, such as motion detectors or sound detectors, are covered by the requirements for intrusion detection units, UL 639.

1.6 A household burglar alarm system covered by these requirements will be designated as Grade A or Grade B. A Grade A system provides supervision of the initiating device circuits, so that if there is an open in the circuit or failure of a transmitter device's ability to communicate with its receiver, the open or failure to transmit will be indicated to the alarm system user. A Grade B system need not provide such supervision.

1.7 Only alarm equipment determined acceptable for Grade A household burglar alarm service may be installed under the requirements contained in the Standard for Installation and Classification of Residential Burglar Alarm Systems, UL 1641.

1.8 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable 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 cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, 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 generally used in the products covered by this standard.

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard or
- b) Is superseded by a requirement in this standard.

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

2.1.4 Specific components are recognized as being 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 for which they have been recognized.

2.1.5 If a digital alarm communicator transmitter is used to transmit signals to a remote location and is to be included as a component of the system, it shall comply with the applicable requirements in the Standard for Digital Alarm Communicator System Units, UL 1635. Otherwise the user must be notified that the off-premises transmission method has not been so investigated.

2.2 Units of Measurement

2.2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.3 Undated References

2.3.1 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.

2.4 Terminology

2.4.1 The term "product" as used in these requirements refers to all types of household burglar-alarm system units.

2.4.2 Unless otherwise indicated, all voltage and current values in this standard are rms.

3 Glossary

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

3.2 **ALARM SIGNAL** – An audible signal indicating an alarm condition requiring immediate action, such as an alarm initiated from an intrusion detector, door switch, floor mat, or the like.

3.3 **ANNUNCIATOR** – An externally-connected electrically operated visual indicating device containing one or more identified targets or indicator lamps in which each target or lamp indicates the circuit condition, location, or both.

3.4 **CIRCUITS, ELECTRICAL** –

- a) **Class 2** – A circuit in which the voltage and power limitations are in accordance with the requirements of Table 29.1 for AC circuits and Table 29.2 for DC circuits.

- b) Class 3 – A circuit in which the voltage and power limitations are in accordance with the requirements of Table 29.1 for AC circuits and Table 29.2 for DC circuits.
- c) 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.
- d) Low-Voltage – A circuit involving a potential of not more than 30 volts AC rms, 42.4 volts DC or AC peak.
- e) Power-Limited – A circuit wherein the power and current are limited as specified in Tables 29.1 and 29.2.

Revised 3.4 effective August 3, 1998

Table 3.1
Power limitations for inherently limited power source
(overcurrent protection not required)

Table 3.2 deleted effective August 3, 1998

Table 3.2
Power limitations for power sources not inherently limited
(overcurrent protection required)

Table 3.2 deleted effective August 3, 1998

3.5 CONTROL UNIT ACCESSORY – A device or appliance externally connected to a control unit that is employed to assure the intended operation of a system or to provide supplementary signaling, annunciation, or both. Examples of control unit accessories are: annunciators, end-of-line resistors or diodes, auxiliary relays, or remote switches.

3.6 DISTINCTIVE SIGNALS – Signals obtained from different sounding appliances, such as bells, horns, sirens, and buzzers, or from a single appliance, such as an electronic horn, where a continuous signal is obtained under one condition and a pulsing signal under another.

3.7 END-OF-LINE RESISTOR – A resistor installed at the end of an initiating or indicating device circuit to limit the amount of supervisory current.

3.8 LINE-VOLTAGE – The voltage at any field connected source of supply, nominally 50 – 60 hertz, and either 115, 208, or 230 volts.

3.9 PRIMARY BATTERY – A battery that by construction is not intended to be recharged.

3.10 SAFETY CIRCUIT – Any circuit that is relied upon to reduce the risk of fire, electric shock, or injury to persons (an interlock circuit, for example).

3.11 SECONDARY BATTERY – A battery that by construction, is intended to be recharged.

3.12 TROUBLE SIGNAL – Visual or audible signal indicating a fault condition of any nature, such as an open or ground or other trouble condition, occurring in the product or connected wiring.

4 Instructions and Drawings

4.1 Each unit shall be provided with installation instructions and drawings that shall include the following information:

- a) Typical installation drawing layouts and a complete representative installation wiring diagram(s) for the product(s) indicating recommended locations and wiring methods that shall be in accordance with the National Electrical Code, ANSI/NFPA 70-1996.
- b) Concise description of the operation, testing, and maintenance procedures for the product(s).
- c) Identification of replacement parts, such as lamps or batteries, by a part number, manufacturer's model number, or the equivalent.
- d) A description of the conditions that might be expected to result in false alarms or impaired operation of the product(s).
- e) A description of the protective features and a warning against bypassing such features.
- f) Instructions that an automatic telephone dialer or similar device shall not be set or programmed to place a call to a police station number that has not been specifically assigned by that police station for such service.

4.2 The user shall be instructed to replace rechargeable batteries as recommended by the battery manufacturer.

4.3 A warning of precautions necessary to prevent premature battery failure, if any precautions are necessary, shall be contained in the installation instructions and shall include position of mounting, temperature limits, state-of-charge, and periods of inactivity if the battery is of a type that may lose capacity due to these conditions. Markings on the unit adjacent to the battery shall indicate battery type and estimated life, and a method of testing battery condition.

4.4 The instructions may be incorporated on the inside of the product, on a separate sheet, or as part of a manual. If not included directly on the product, the instructions or manual shall be referenced in the marking information on the product. See Markings, Section 86.

CONSTRUCTION

ASSEMBLY

5 General

5.1 Unless specifically indicated otherwise, the construction requirements specified for a product shall apply also for any remote accessories with which it is to be employed.

5.2 Uninsulated high-voltage live parts or moving parts that may cause injury to persons shall be located, guarded, or enclosed to prevent contact by persons during servicing conditions such as relamping, changing fuses, adjusting controls, battery replacement and maintenance, and operating switches. Protection by insulating tape, barriers, or the equivalent, overexposed current-carrying parts operating at high-voltage meets these requirements.

6 Test Features

6.1 Means provided for testing the battery condition or other aspect of the system, shall not result in a risk of fire, electric shock, or injury to persons, and shall be constructed and located to prevent unintended operation of the system by unauthorized personnel.

6.2 The product shall be provided with a test feature or method that will evaluate the capability of each critical component, from sensor(s) to alarm, under all modes of operation.

Exception: A critical component provided with a trouble or alarm signal need not be evaluated by the test feature. A product employing a trouble or alarm signal on each critical component need not have a test feature.

6.3 With reference to the requirements in 6.2, a critical component is defined as a component whose malfunctioning will impair the intended operation of the product or may involve a risk of fire or electric shock.

7 Enclosures

7.1 General

7.1.1 The frame and enclosure shall have strength and rigidity to resist total or partial collapse and the attendant reduction of spacings, loosening or displacement of parts, and development of other conditions that may impair operation of the product or increase the risk of fire, electric shock, or injury to persons. See Tables 7.1 – 7.3 and the Mechanical Strength Test for Enclosures, Section 56.

7.1.2 Electrical parts of a product shall be located or enclosed to provide protection against unintentional contact with uninsulated high-voltage live parts.

7.1.3 Operating parts, such as gear mechanisms, light-duty relays, and similar devices, shall be enclosed to protect against malfunction from dust or other material that may impair their intended operation. See the Dust Test, Section 40.

7.1.4 The mounting means of an enclosure shall be accessible without disassembly of any operating part of the product. Removal of a completely assembled panel to mount the enclosure is not considered to be disassembly of an operating part.

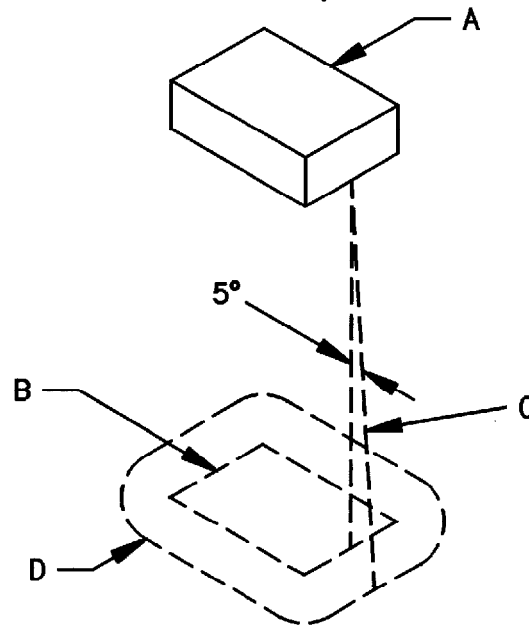
7.1.5 An enclosure shall be constructed to minimize the possibility of emission of flame, molten metal, flaming or glowing particles, or flaming drops. See the Abnormal Operation Test, Section 47 and the Ignition Through Bottom-Panel Openings Test, Section 55.

7.1.6 The requirement in 7.1.5 necessitates either a nonflammable bottom in accordance with 7.2.3, or a protective barrier as described in Figure 7.1 under all areas containing flammable materials.

Exception: Materials or assemblies classified as 94V-1 need not comply with this requirement; see the Standard for tests for Flammability of Plastic Material for Parts in Devices and Appliances, UL 94.

7.1.7 A construction employing individual barriers under components, groups of components or assemblies, as specified in Figure 7.1, is to be considered as complying with the requirement in 7.1.6.

Figure 7.1
Protective pan



EB120A

A. The entire component under which a barrier (flat or dish with or without a lip or other raised edge) of noncombustible material is to be provided. The sketch above is of a metal enclosed component with ventilating openings to show that the protective barrier is required only for those openings from which flaming parts might come. If the component or assembly does not have its own noncombustible enclosure, the area to be protected would be the entire area occupied by the component or assembly.

B. Projection of the outline of the area of (A) which needs a bottom barrier vertically downward onto the horizontal plane of the lowest point on the outer edge (D) of the barrier.

C. Inclined line that traces out an area (D) on the horizontal plane of the barrier. Moving around the perimeter of the area (B) which needs a bottom barrier, this line projects at a 5-degree angle from the line extending vertically at every point around the perimeter of (A) and oriented to trace out the largest area, except that the angle may be less than 5 degrees if the barrier or portion of the bottom cover contacts a vertical barrier or side panel of noncombustible material, or if the horizontal extension of the barrier (B) to (D) would exceed 6 inches (150 mm).

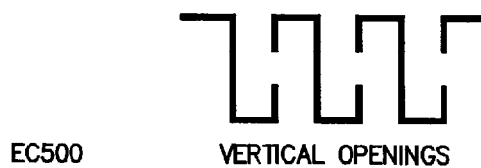
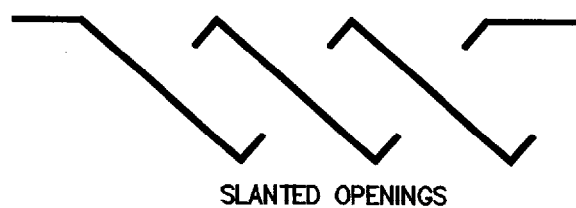
D. Minimum outline of the barrier, except that the extension B – D need not exceed 6 inches (150 mm) (flat or dished with or without lip or other raised edge). The bottom of the barrier may be flat or formed in any manner provided that every point of area (D) is at or below the lowest point on the outer edge of the barrier.

7.2 Openings

7.2.1 Openings directly over uninsulated high-voltage live parts shall not exceed 0.187 inch (4.75 mm) in any dimensions or shall be of a configuration as illustrated by Figure 7.2 for top cover designs and Figure 7.3 for side openings. See also 7.2.2.

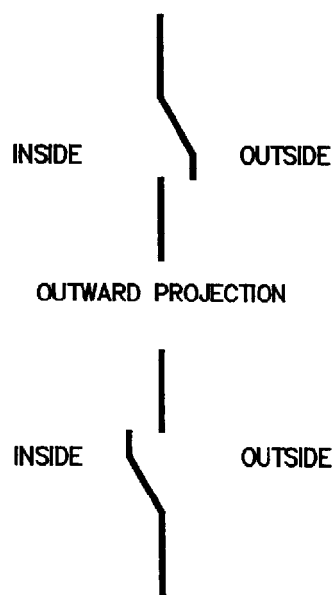
7.2.2 An opening shall not permit entrance of a 1 inch (25.4 mm) diameter rod and shall be sized and arranged so that a probe, as illustrated in Figure 7.4, cannot be made to contact any uninsulated live electrical part (other than low-voltage) when inserted through the opening in a straight or articulated position.

Figure 7.2
Cross sections of top cover designs



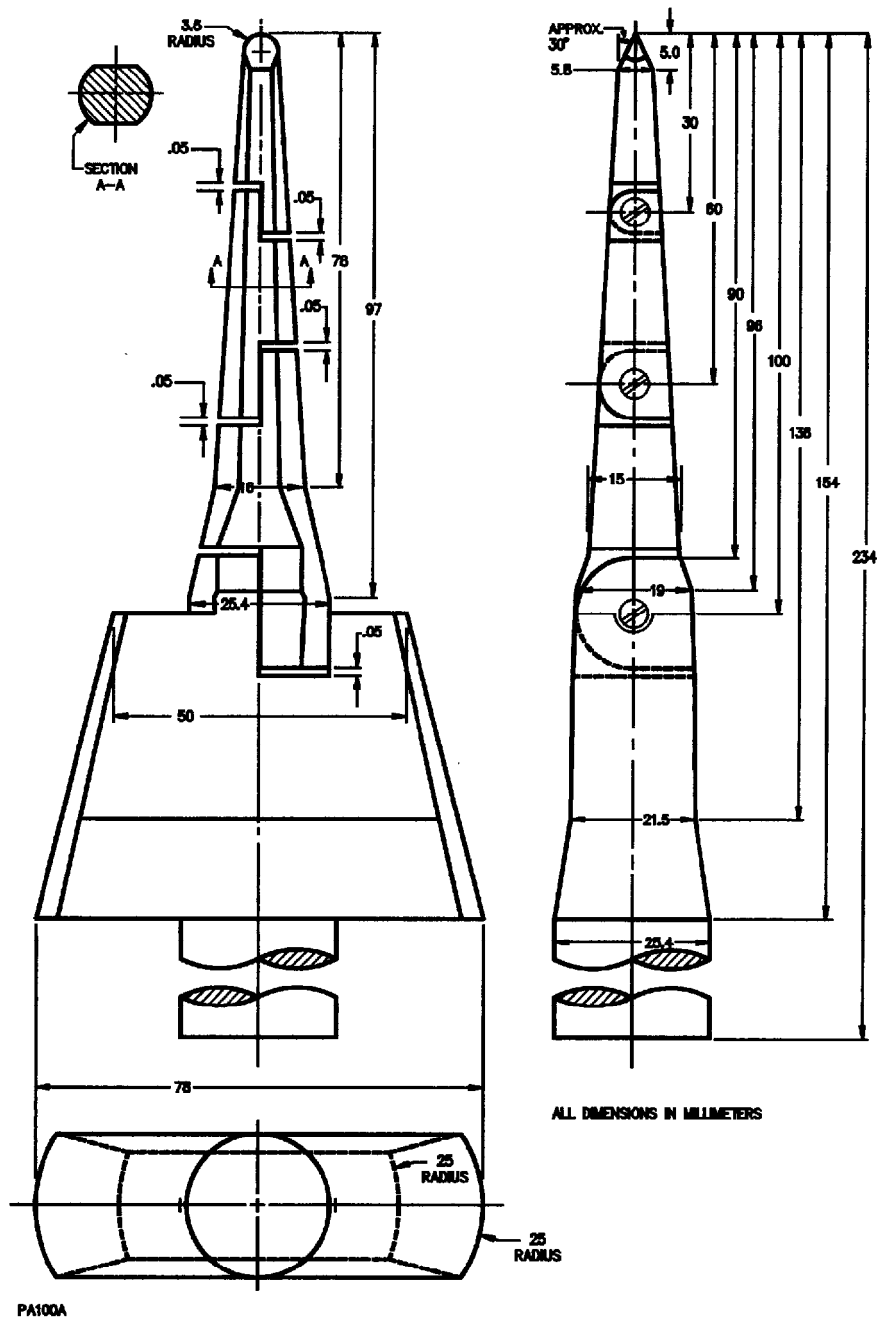
EC500

Figure 7.3
Louvers



EC510

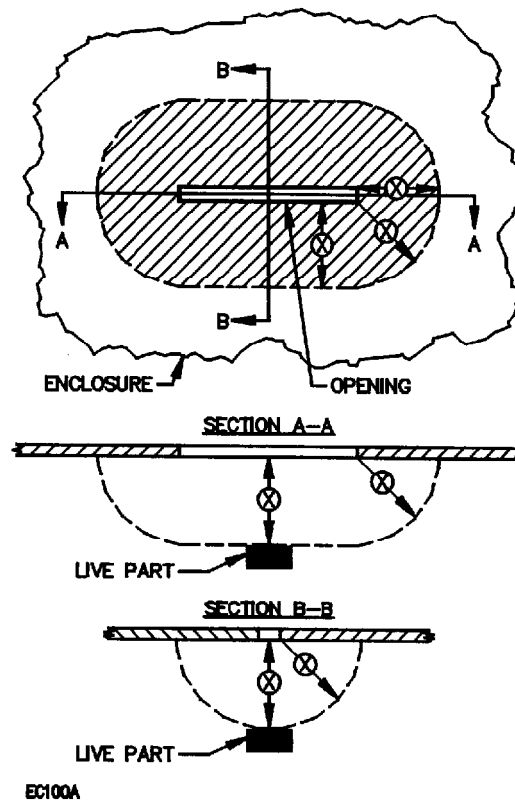
INWARD PROJECTION

Figure 7.4
Probe

High impact polystyrene articulate probes are available from Underwriters Laboratories Inc.

7.2.3 An opening that permits entrance of a 1 inch (25.4-mm) diameter rod is acceptable under the conditions described in Figure 7.5.

Figure 7.5
Openings over 1 inch (25.4 mm) wide



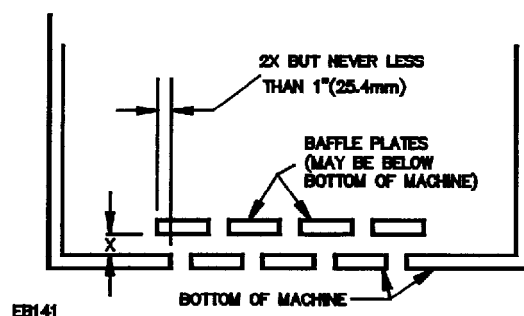
The opening is acceptable if, within the enclosure, there is no uninsulated live part or enamel-insulated wire:

- a) Less than X inches (mm) from the perimeter of the opening, as well as
- b) Within the volume generated by projecting the perimeter X inches (mm) normal to its plane.

X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 6-1/16 inch (154 mm).

7.2.4 Openings may be provided in the bottom panels or protective pans under areas containing materials not classified at least 94V-1 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, if constructed in a manner that prevents materials from falling directly from the interior of the product onto the supporting surface or onto any other location under the product. Figure 7.6 illustrates a type of baffle that complies with this requirement. A second construction that complies with this requirement is a 0.040 inch (1.02 mm) sheet steel bottom panel in which 5/64 inch (2.0 mm), maximum, round holes are spaced no closer than 1/8 inch (3.2 mm) center-to-center. Constructions other than these two are acceptable if they comply with the requirements of the Ignition Through Bottom Panel Openings Tests, Section 55.

Figure 7.6
Baffle



7.2.5 The bottom of the enclosure under areas containing only materials classified as 94V-1 or less flammable may have openings not larger than 1/16 square inch (40.3 mm²).

7.2.6 Openings are acceptable, without limitation of the size or number of openings in areas containing only PVC, TFE, CTFE, FEP, and neoprene insulated wire or cable, in areas containing plugs and receptacles, and in areas underneath impedance-protected or thermally-protected motors.

7.2.7 Openings in the enclosure shall not give access to any relays, terminals, controls, or related components that might be subject to tampering by hand or with tools.

7.3 Cast metal

7.3.1 The minimum thickness of cast metal for an enclosure shall be as indicated in Table 7.1.

Exception: Cast metal of lesser thickness may be employed if, consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See the Drop Test, Section 53, and the Mechanical Strength Tests for Enclosures, Section 56.

Table 7.1
Cast-metal electrical enclosures

Use, or dimension of area involved	Minimum thickness, inch (mm)			
	Die-cast metal		Cast metal of other than the die-cast type	
Area of 24 square inches (155 cm ²) or less and having no dimension greater than 6 inches (152 mm)	1/16	1.6	1/8	3.2
Area greater than 24 square inches (155 cm ²) or having any dimension greater than 6 inches (152 mm)	3/32	2.4	1/8	3.2
At a threaded conduit hole	1/4	6.4	1/4	6.4
At an unthreaded conduit hole	1/8	3.2	1/8	3.2
^a The area limitation for metal 1/16 inch (1.6 mm) in thickness may be obtained by the provision of reinforcing ribs subdividing a larger area.				

7.4 Sheet metal

7.4.1 The thickness of sheet metal employed for the enclosure of a product shall be not less than that indicated in Table 7.2 or 7.3, whichever applies.

Exception: Sheet metal of lesser thickness may be employed if consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See the Drop Test, Section 53, and the Mechanical Strength Tests for Enclosures, Section 56.

7.4.2 A sheet metal member to which a wiring system is to be connected in the field shall have a thickness of not less than 0.032 inch (0.81 mm) if of uncoated steel, 0.034 inch (0.86 mm) if of galvanized steel, and 0.045 inch (1.14 mm) if of nonferrous metal.

7.5 Nonmetallic

7.5.1 If nonmetallic material is used for an enclosure, it shall have a wall thickness of not less than 1/16 inch (1.6 mm).

7.5.2 Among the factors to be taken into consideration when determining the acceptability of a nonmetallic enclosure are:

- a) The mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;
- d) Flammability and resistance to ignition from electrical sources;
- e) Dielectric strength, insulation resistance, and resistance to arc tracking; and
- f) Resistance to distortion and creeping at temperatures to which the material may be subjected under any conditions of use.

All these factors are to be considered with respect to aging in accordance with the Tests on Polymeric Materials requirements (see Section 50). See the Drop Test, Section 53, and the Mechanical Strength Tests for Enclosures, Section 56.

7.6 Doors, covers, and guards

7.6.1 An enclosure cover shall be hinged, sliding, or similarly attached to prevent its being removed if:

- a) It gives access to fuses or any other overcurrent protective device, the intended protective functioning of which requires renewal; or
- b) It is necessary to open the cover in connection with the intended operation of the unit.

Exception: An enclosure cover need not comply with this requirement if its position is supervised by a tamper contact that is connected in the closed protective circuit.

7.6.2 Cabinet locks or equivalent means requiring a tool or key shall be used for all enclosures if access is not required for intended operation of the product.

Table 7.2
Minimum thickness of sheet metal for electrical enclosures
carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness uncoated,		Minimum thickness metal coated,	
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	inch (mm) [MSG]		inch (mm) [GSG]	
4.0 10.2	Not limited	6.25 15.9	Not limited	0.020 0.51		0.023 0.58	
4.75 12.1	5.75 14.6	6.75 17.1	8.25 21.0	[24]		[24]	
6.0 15.2	Not limited	9.5 24.1	Not limited	0.026 0.66		0.029 0.74	
7.0 17.8	8.75 22.2	10.0 25.4	12.5 31.8	[22]		[22]	
8.0 20.3	Not limited	12.0 30.5	Not limited	0.032 0.81		0.034 0.86	
9.0 22.9	11.5 29.2	13.0 33.0	16.0 40.6	[20]		[20]	
12.5 31.8	Not limited	19.5 49.5	Not limited	0.042 1.07		0.045 1.14	
14.0 35.6	18.0 45.7	21.0 53.3	25.0 63.5	[18]		[18]	
18.0 45.7	Not limited	27.0 68.6	Not limited	0.053 1.35		0.056 1.42	
20.0 50.8	25.0 63.5	29.0 73.7	36.0 91.4	[16]		[16]	
22.0 55.9	Not limited	33.0 83.8	Not limited	0.060 1.52		0.063 1.60	
25.0 63.5	31.0 78.7	35.0 88.9	43.0 109.2	[15]		[15]	
25.0 63.5	Not limited	39.0 99.1	Not limited	0.067 1.70		0.070 1.78	
29.0 73.7	36.0 91.4	104.1 104.1	51.0 129.5	[14]		[14]	
33.0 83.8	Not limited	51.0 129.5	Not limited	0.080 2.03		0.084 2.13	
38.0 96.5	47.0 119.4	54.0 137.2	66.0 167.6	[13]		[13]	
42.0 106.7	Not limited	64.0 162.6	Not limited	0.093 2.36		0.097 2.46	
47.0 119.4	59.0 149.9	68.0 172.7	84.0 213.4	[12]		[12]	
52.0 132.1	Not limited	80.0 203.2	Not limited	0.108 2.74		0.111 2.82	
60.0 152.4	74.0 188.0	84.0 213.4	103.0 261.6	[11]		[11]	
63.0 160.0	Not limited	97.0 246.4	Not limited	0.123 3.12		0.126 3.20	
73.0 185.4	90.0 228.6	103.0 261.6	127.0 322.6	[10]		[10]	

^a 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 sufficient 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. Construction considered to be without supporting frame includes:

- 1) A single sheet with single support flanges (formed edges);
- 2) A single sheet that is corrugated or ribbed; and
- 3) An enclosure surface loosely attached to a frame, that is, with spring clips.

^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.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

Table 7.3
Minimum thickness of sheet metal for electrical enclosures
aluminum, copper, or brass

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

^a 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 sufficient 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. Construction considered to be without supporting frame includes:

- 1) A single sheet with single support flanges (formed edges);
- 2) A single sheet that is corrugated or ribbed; and
- 3) An enclosure surface loosely attached to a frame, that is, with spring clips.

^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.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

7.7 Screens and expanded metal

7.7.1 Perforated sheet steel and sheet steel employed for expanded metal mesh shall be:

- a) At least 0.042 inch (1.07 mm) thick [0.045 inch (1.17 mm) if zinc coated] if the mesh openings or perforations are 1/2 square inch (323 mm²) or less in area; and
- b) At least 0.080 inch (2.03 mm) thick [0.084 inch (2.13 mm) if zinc coated] for larger openings.

The largest dimension shall not exceed 4 inches (102 mm).

Exception: If the indentation of a guard or the enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to impair performance or reduce spacings below the minimum required values (see Spacings, Section 28), 0.020 inch (0.53 mm) expanded metal mesh or perforated sheet metal [0.023 inch (0.58 mm) if zinc coated] may be employed, provided that:

- a) The exposed mesh on any one side or surface of the product so protected has an area of not more than 72 square inches (464 cm²) and has no dimension greater than 12 inches (305 mm), or*
- b) The width of an opening so protected is not greater than 3-1/2 inches (89 mm).*

7.7.2 The wires of a screen shall be not less than No. 16 AWG (1.3 mm²) steel if the screen openings are 1/2 square inch (323 mm²) or less in area, and shall be not less than No. 12 AWG (2.1 mm²) steel for larger screen openings.

8 Electric Shock

8.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See the Electric Shock Current Test, Section 35.

8.2 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The conductive connection shall have a maximum resistance of 5.2 megohms, a minimum wattage rating of 1/2 watt, and shall be effective with the power switch in either the on or off position.

Exception: The conductive connection need not be provided if:

- a) Such a connection is established in the event of electrical breakdown of the antenna isolating means,*
- b) The breakdown does not result in a risk of electric shock, and*
- c) In a construction employing an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 megohms.*

8.3 The maximum value of 5.2 megohms mentioned in 8.2 is to include the maximum tolerance of the resistor value used; that is, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance is acceptable. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors may be rated a minimum of 1/4 watt.

8.4 The insertion in any socket of any vacuum tube, semiconductor, or similar replaceable circuit element used in the product shall not result in a risk of electric shock.

9 Protection Against Corrosion

9.1 Iron and steel parts, other than bearings, and the like, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

9.2 The requirement of 9.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which mechanical operation may depend. Bearing surfaces shall be of such materials and design as to resist binding due to corrosion.

Exception No. 1: This requirement does not apply to parts such as washers, screws, bolts, and the like, if corrosion of such unprotected parts would not result in risk of fire or electric shock, or in unintentional contact with moving parts that can cause a risk of injury to persons or impair the operation of the unit.

Exception No. 2: Parts made of stainless steel, polished or treated, if necessary, do not require additional protection against corrosion.

9.3 Metal shall not be used in combinations that can cause galvanic action.

9.4 Cabinets and enclosures of corrosion-resistant material may be employed without special corrosion protection.

FIELD WIRING CONNECTIONS

10 General

10.1 A household burglar-alarm system unit shall have provision for connection to a commercial light and power source available in a residential household or to a battery supply. This may be:

- a) A permanent connection by means of wiring terminals or leads in a separate wiring compartment that has provision for the connection of conduit or metal-clad cable,
- b) A power-supply cord and attachment plug, or
- c) Plug-in or permanently mounted Class 2 transformer for AC powered units.

10.2 Control units intended to be installed by other than a qualified electrician shall be powered by a line cord or from a low-voltage limited energy power supply. See 3.4(b).

11 Cord-Connected Products

11.1 A product that is intended to be movable shall be provided with at least 6 feet (1.8 m) of flexible cord terminated in a two- or three-prong attachment plug of acceptable type and rating for connection to the supply circuit.

Exception: The cord may be less than 6 feet (1.8 m) in length if it is evident that the use of a longer cord:

- a) *May result in a risk of fire or electric shock;*
- b) *May result in unintentional contact with moving parts that may cause a risk of injury to persons; or*
- c) *Is not required for the intended operation of the product.*

11.2 The flexible cord shall be of Type SP-1, SPT-1, SP-2, SPT-2, SV, SVT, SJ, SJT, or equivalent, minimum No. 18 AWG (0.82 mm²). It shall be rated for use at the voltage and current ratings of the appliance.

11.3 Means shall be provided to prevent the flexible cord from being pushed into the enclosure through the cord-entry hole if such displacement can:

- a) Subject the cord to mechanical damage or to a temperature higher than that for which the cord is rated,
- b) Reduce spacings below the minimum acceptable values, or
- c) Result in damage to internal components.

11.4 If a flexible cord passes through any opening in a wall, barrier, or enclosing case, the edges of the hole shall be smooth and rounded, without burrs, fins, or sharp edges which may damage the cord jacket.

11.5 A restraining means shall be provided for securing the attachment plug or plug-in transformer to the receptacle.

11.6 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section 54.

11.7 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, that may cause abrasion of the insulation on the conductors.

11.8 Clamps of any material (metal or otherwise) are acceptable for use on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

12 Permanently Connected Products

12.1 Wiring terminals or leads shall be provided for connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70-1996.

12.2 A field wiring terminal shall comply with:

- a) 12.4 and 12.6 – 12.10;
- b) The field wiring requirements in the requirements for electrical quick-connect terminals, UL 310;
- c) The requirements in the Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors, UL 486A;
- d) The requirements for equipment wiring terminals for use with aluminum and/or copper conductors, UL 486E; or
- e) The field wiring requirements (Code 2) in the requirements for terminal blocks, UL 1059.

The current-carrying parts shall be silver, copper, a copper alloy, or a similar nonferrous conductive material. Securing screws and the like may be plated steel. Equipment provided with quick-connect terminals intended for field termination of electrical conductors to the equipment and complying with UL 310, shall be provided with strain relief, and the installation instructions shall include instructions for effecting the strain relief and include reference to the specific connectors to be used.

12.3 If leads are provided in lieu of wiring terminals, they shall be not less than 6 inches (152 mm) long, and not smaller than No. 22 AWG (0.32 mm^2) except that leads intended for connection of a line-voltage source shall be not smaller than No. 18 AWG (0.82 mm^2).

Exception No. 1: The lead may be less than 6 inches (152 mm) long if it is evident that the use of a longer lead may result in damage to the insulation.

Exception No. 2: Solid copper leads as small as No. 26 AWG (0.13 mm^2) may be used if:

- a) The current does not exceed 1 ampere for lengths up to 2 feet (61 cm) and the current does not exceed 0.4 amperes for lengths up to 10 feet (3.05 m),*
- b) There are two or more conductors and they are covered by a common jacket or the equivalent,*
- c) The assembled conductors comply with the requirements of 57.3 for strain relief, and*
- d) The installation instructions shall indicate that the lead shall not be spliced to a conductor larger than No. 18 AWG (0.82 mm^2).*

12.4 Soldering lugs or solderless (pressure) wire connectors shall be used for No. 8 AWG (8.4 mm^2) and larger wires. For No. 10 AWG (5.3 mm^2) and smaller wires, the parts to which wiring connections are made may consist of clamps or connections are made may consist of clamps or binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position.

12.5 Wiring terminals shall be prevented from turning.

12.6 A wire binding screw, if employed at a wiring terminal, shall be not smaller than No. 8 (4.2 mm diameter).

Exception: A No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 14 AWG (2.1 mm^2) or smaller conductor, and a No. 4 (2.8 mm diameter) screw may be used for the connection of a No. 19 AWG (0.65 mm^2) or smaller conductor.

12.7 A wire binding screw shall thread into metal.

12.8 A terminal plate tapped for a wire binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick if used with a No. 8 (4.2 mm diameter) or larger screw, and not less than 0.030 inch (0.76 mm) thick if used with a No. 6 (3.5 mm diameter) or a No. 4 (2.8 mm diameter) screw, and shall have not fewer than two full threads in the metal. See also 12.9.

12.9 A terminal plate may have the metal extruded at the tapped hole for the binding screw to provide the two full threads. Other constructions may be employed if they provide equivalent thread security of the wire binding screw.

12.10 If two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be employed for each additional conductor. A separator washer is not required if two conductors are separated and intended to be secured under a common clamping plate. If the wires protrude above terminal barriers, the nonferrous separator shall include means, such as upturned tabs or sides to retain the wire.

13 Special Terminal Assemblies

13.1 Special wiring terminals shall be prevented from turning.

13.2 Any of the following terminal configurations may be employed for connection of field wiring if they comply with all of the requirements in 13.3.

a) Push-In Terminals – Nonferrous (screwless) push-in terminals of the type employed on some switches and receptacles wherein solid conductors may be pushed into slots containing spring-type contacts. The leads can be removed by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals are not acceptable for use with aluminum conductors. The marking adjacent to the terminal shall indicate that only copper conductors are to be used.

b) Quick-Connect Terminals – Nonferrous quick-connect (push-type) terminals consisting of male posts permanently secured to the device and provided with compatible female connectors for connection to field wiring. Requires special tool for crimping of field wires. Mating terminals shall be shipped with the product, with instructions for their installation.

c) Solder Terminals – Conventional nonferrous solder terminals.

d) Solderless Wrapped Terminals – Nonferrous terminals that require a special tool and terminal post design.

e) Telephone Type Terminals – Nonferrous terminal plates employing a narrow V-shaped slot for securing of a conductor in a special post design, and requiring a special tool for wire connection.

f) Other Terminals – Other terminal connections may be employed if determined to be equivalent to those described in items (a) – (e).

13.3 Any of the terminal configurations listed in 13.2 may be employed for connection of field wiring if they comply with all of the following:

a) If a special tool is required for connection, its use shall be indicated on the installation wiring diagram and the name of the manufacturer and the model number or equivalent shall also be indicated along with information as to where the tool may be obtained.

b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size to be employed shall be not smaller than No. 22 AWG (0.32 mm²).

c) The wire size to be employed shall have ampacity for the circuit application.

d) The terminal configuration shall comply with the requirements for the Special Terminal Assemblies Tests, Section 57.

Exception: Terminals complying with the requirements in any of the standards specified in 12.2 (b) – (e) are not required to be subjected to the Special Terminal Assemblies Tests, Section 57.

14 Polarity Identification

14.1 In a product intended to be connected to a grounded circuit, one terminal or lead shall be identified for the connection of the grounded conductor. The identified terminal or lead shall be the one which is connected to the screw shells of lampholders and to which no primary overcurrent-protective devices or other switching devices of the single-pole type are connected.

14.2 A terminal intended for the connection of a grounded supply conductor shall be composed of or plated with metal that is white in color and shall be distinguishable from the other terminals or identification of the terminal shall be clearly shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or natural gray color and shall be distinguishable from the other leads.

INTERNAL WIRING AND ASSEMBLY

15 General

15.1 Internal wiring shall have thermoplastic or rubber insulation not less than 1/64 inch (0.4 mm) thick for 0 – 300 volts if power is less than 375 volt-amperes, current is less than 5 amperes, and the wiring is not subject to flexing or mechanical abuse. Otherwise, thermoplastic or rubber insulation not less than 1/32 inch (0.8 mm) thick rated 600 volts shall be used. Other insulating material of lesser thickness may be used if it has equivalent insulating and mechanical properties.

15.2 Leads or a cable assembly, connected to parts mounted on a hinged cover, shall be of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged to reduce the risk of abrasion of insulation and jamming between parts of the enclosure.

15.3 Insulation, such as coated fabric and extruded tubing, shall not physically or electrically deteriorate as a result of exposure to the temperature or other environmental conditions to which it may be subjected in its intended use.

15.4 Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, and the like, that may cause abrasion of the conductor insulation. Holes in sheet metal walls through which insulated wires pass shall be provided with a bushing if the wall is 0.042 inch (1.07 mm) or less thick. Holes in walls thicker than 0.042 inch shall have smooth, rounded edges.

15.5 Each splice and connection shall be mechanically secure and bonded electrically.

15.6 Stranded conductors clamped under wire binding screws or similar parts shall have the individual strands soldered together or equivalently arranged.

15.7 A splice shall be provided with insulation equivalent to that of the wires involved.

15.8 A printed wiring assembly shall comply with the requirements for printed-wiring boards, UL 796.

16 Separation of Circuits

16.1 Internal wiring of circuits that operate at different potentials shall be separated by barriers, clamps, routing, or other equivalent means, unless all conductors are provided with insulation that is rated for the higher potential involved.

16.2 The thickness of a metal barrier shall not be less than the specified value as required by Table 7.1, 7.2, or 7.3, whichever is applicable, based on the size of the barrier. A barrier of insulating material shall be at least 0.028 inch (0.71 mm) thick. Any clearance between the edge of a barrier and a compartment wall shall be not more than 1/16 inch (1.6 mm).

17 Bonding for Grounding

17.1 An exposed dead metal part of a product using high voltage, that may become energized, shall be bonded to the equipment grounding connection. See Equipment Grounding Connection, Section 18.

17.2 Uninsulated metal parts of cabinets, electrical enclosures, and other electrical components of a product using high voltage shall be bonded for grounding if they may be contacted by persons.

17.3 Metal parts described as follows need not be grounded:

- a) Adhesive-attached metal-foil markings, screws, handles, and the like, that are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by a grounded metal part so that they are not likely to become energized.
- b) Isolated metal parts, such as small assembly screws, and the like, that are physically separated from wiring and insulated live metal parts.
- c) Panels and covers that do not enclose uninsulated live parts if wiring is separated from the panel or cover so that they are not likely to become energized.
- d) Panels and covers that are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar materials not less than 0.028 inch (0.71 mm) thick, and secured in place.

17.4 A bonding means shall be an electrical conductor. If of ferrous metal, it shall be protected against corrosion by painting, plating, or the equivalent. The conductor shall be of acceptable size, see 17.9. A separate bonding conductor shall be installed so it is protected from mechanical damage.

17.5 The bonding shall be by a positive means, such as clamping or riveting; by bolted or screwed connections; or by brazing or welding. The bonding connection shall penetrate nonconductive coatings such as paint. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar materials.

17.6 A bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings, if required for compliance with 17.5.

17.7 If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw engaging metal is acceptable for compliance with 17.5.

17.8 Metal-to-metal hinge-bearing members for doors or covers are acceptable as a means for bonding the door or cover for grounding if a multiple bearing-pin type (piano-type) hinge is employed.

17.9 The size of a copper or aluminum conductor, employed to bond an electrical enclosure, shall be based on the rating of the branch-circuit overcurrent device by which the equipment will be protected. The size of the conductor shall be in accordance with Table 17.1.

17.10 A conductor, such as a clamp or strap, used in place of a separate wire conductor is acceptable, if the minimum cross-sectional conducting area of the bonding means is equivalent to the wire specified in Table 17.1.

Table 17.1
Bonding wire conductor size

Rating of overcurrent device, amperes	Size of bonding conductor ^a			
	Copper wire,		Aluminum wire,	
	AWG	(mm ²)	AWG	(mm ²)
15	14	2.1	12	3.3
20	12	3.3	10	5.3
30	10	5.3	8	8.4
40	10	5.3	8	8.4
60	10	5.3	8	8.4
100	8	8.4	6	13.3
200	6	13.3	4	21.2

^a Or equivalent cross-sectional area.

17.11 A splice shall not be employed in a wire conductor used for bonding electrical enclosures or other electrical components.

18 Equipment Grounding Connection

18.1 The following are considered to constitute means for grounding:

- a) In a product intended to be permanently connected by a metal-enclosed wiring system, a knockout or equivalent opening in the metal enclosure.
- b) In a product intended to be connected by a nonmetallic-enclosed wiring system, such as nonmetallic-sheathed cable or multiple-conductor cord, an equipment grounding terminal or lead.

18.2 On an equipment grounding terminal, a wire binding screw intended for the connection of an equipment grounding conductor shall have a green colored head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified by being marked "G," "GR," "GROUND," "GROUNDING," or the like, or by a marking on a wiring diagram provided on the unit. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the unit and shall be located so that it is unlikely to be removed during servicing of the unit.

18.3 The surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green color or a continuous green color with one or more yellow stripes, and no other lead shall be so identified.

18.4 If a multiple-conductor cord is employed, the insulation of the grounding conductor shall be finished with a continuous green color or with a continuous green color with one or more yellow stripes. The grounding conductor shall be secured to the grounding terminal or lead at the enclosure and to the grounding blade or equivalent contacting member of an attachment plug. In no case shall a green-identified conductor of a cord be used as a circuit conductor. Solder alone shall not be used for securing the grounding conductor.