UL 1023

STANDARD FOR SAFETY

Household Burglar-Alarm System Units

UL Standard for Safety for Household Burglar-Alarm System Units, UL 1023

Seventh Edition, Dated September 1, 2017

Summary of Topics

This revision of ANSI/UL 1023 dated May 20, 2021 includes a clarification of short range RF requirements for household burglar alarm products to address frequency hoping and spread spectrum technologies; 62.3, 63.1, 63.4, 63.5, 64.1, 67.2, and 68.3

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 January 29, 2021.

No Text on This Page

SEPTEMBER 1, 2017
(Title Page Reprinted: May 20, 2021)

ANSI/UL 1023-2021

UL 1023

Standard for Household Burglar-Alarm System Units

First Edition – March, 1972
Second Edition – August, 1978
Third Edition – October, 1978
Fourth Edition – September, 1985
Fifth Edition – September, 1991
Sixth Edition – November, 1996

Seventh Edition

September 1, 2017

This ANSI/UL Standard for Safety consists of the Seventh edition including revisions through May 20, 2021.

The most recent designation of ANSI/UL 1023 as an American National Standard (ANSI) occurred on May 20, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

ASSEMBLY

FIELD-WIRING CONNECTIONS

INTERNAL WIRING AND ASSEMBLY

ELECTRICAL COMPONENTS

SPACINGS

PERFORMANCE

GENERAL

SHORT-RANGE RADIO FREQUENCY DEVICES

SHORT-RANGE WIRELESS DEVICES

MANUFACTURING AND PRODUCTION TESTS

MARKINGS

ACCESSORY EQUIPMENT

APPENDIX A

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 A combination household fire and burglar alarm system shall also comply with the Standard for Household Fire Warning System Units, UL 985.

1.5 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.

1.6 Intrusion detection devices, such as motion detectors or sound detectors, are covered by the Standard for Intrusion-Detection Units, UL 639.

1.7 A household burglar alarm system shall provide 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.

1.8 Only alarm equipment determined acceptable for 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.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.5 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. For other transmission methods, the system shall comply with the Standard for Central Station Burglar Alarm Units, UL 1610 (with the applicable exceptions for residential applications). Otherwise the user must be notified that the off-premises transmission method has not been so investigated.

Exception: Packet switched data network alarm communicator transmitters intended for use in residential burglar-alarm systems are not required to identify and report a loss of connection/signal within 200 seconds at the central station receiving unit. The transmitter shall contact the receiver with an identifiable signal at least once every 30 days.

3 Units of Measurement

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

4 Undated References

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

5 Terminology

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

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

6 Glossary

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

6.2 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.

6.3 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.

6.4 CIRCUITS, ELECTRICAL –

a) Class 2 – A circuit in which the voltage and power limitations are in accordance with the requirements of Table 32.1 for AC circuits and Table 32.2 for DC circuits.

b) Class 3 – A circuit in which the voltage and power limitations are in accordance with the requirements of Table 32.1 for AC circuits and Table 32.2 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 Table 32.1 and Table 32.2.

6.5 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.

6.6 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.

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

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

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

6.10 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).

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

6.12 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.

6.13 TRAINED INSTALLER – An individual knowledgeable in the product operation and who has received instruction on installing the product.

7 Instructions and Drawings

7.1 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.

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.

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

7.3 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.

7.4 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, Details, Section 89.

Exception No. 1: For products intended only to be installed by a trained installer, the installation instructions containing the information required by 7.1 – 7.3 is not prohibited from being made available by one or more of the following means:

a) Electronic instructions within the basic product software;

b) Electronic media such as website, CD-ROM, DVD, etc.; or

c) When the instructions are included as described in (a) or (b), the instructions shall be referenced in the product marking by:

1) Name or trademark of manufacturer,

2) Drawing number, URL address (This may be a root or home page and not a specific location), and/or equivalent identification, and

3) Issue date, revision level, and/or release date, or equivalent information such as date of manufacture or firmware level, which correlates the applicable digital manual revision to the product's current hardware/software. (For example, the product is marked with the date of manufacture or firmware level and the digital manual references the date or firmware range to which the manual is applicable).

Exception No. 2: Installation instructions for products that require an Internet connection for initial configuration containing the information required by 7.1 – 7.3 is not prohibited from being made available by the means provided in 7.4, Exception No. 1, given the requirements of one of the following are met:

a) Where hardcopy installation instructions are not provided, the product annunciates an audible trouble signal when the product is energized until the product is setup; or

b) A constant signal visible to the user after the product is installed is permitted to be used in lieu of the audible trouble signal required by 7.4 Exception No. 2 (a) when the following information is provided in hardcopy with the product:

1) Statement the device must be installed and configured before it is to be used,

2) Statement the full manual is to be obtained before installation is started and the website or online location where it is available, and

3) Description of the visual indication given and its meaning.

CONSTRUCTION

ASSEMBLY

8 General

8.1 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.

8.2 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, over exposed current-carrying parts operating at high-voltage meets these requirements.

9 Test Features

9.1 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.

9.2 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.

9.3 With reference to the requirements in 9.2, 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.

10 Enclosures

10.1 General

10.1.1 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 Table 10.1 – Table 10.3 and the Mechanical Strength Test for Enclosures, Section 59.

Table 10.1
Cast-metal electrical enclosures

Use, or dimension of area involved	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast type,	
	inch	(mm)	inch	(mm)
Area of 24 square inches (155 cm^2) or less and having no dimension greater than 6 inches (152 mm)[a]	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.

Table 10.2
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]		Maximum length,[c]		Maximum width,[b]		Maximum length,		inch	(mm)	inch	(mm)
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	[MSG]		[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]	

Table 10.2 Continued on Next Page

Table 10.2 Continued

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, inches (cm)	inch (mm) [MSG]	inch (mm) [GSG]

[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 10.3
Minimum thickness of sheet metal for electrical enclosures aluminum, copper, or brass

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

[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

Table 10.3 Continued on Next Page

Table 10.3 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Minimum thickness,
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inches (mm)
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.								

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

10.1.3 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 43.

10.1.4 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.

10.1.5 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 50 and the Ignition Through Bottom-Panel Openings Test, Section 58.

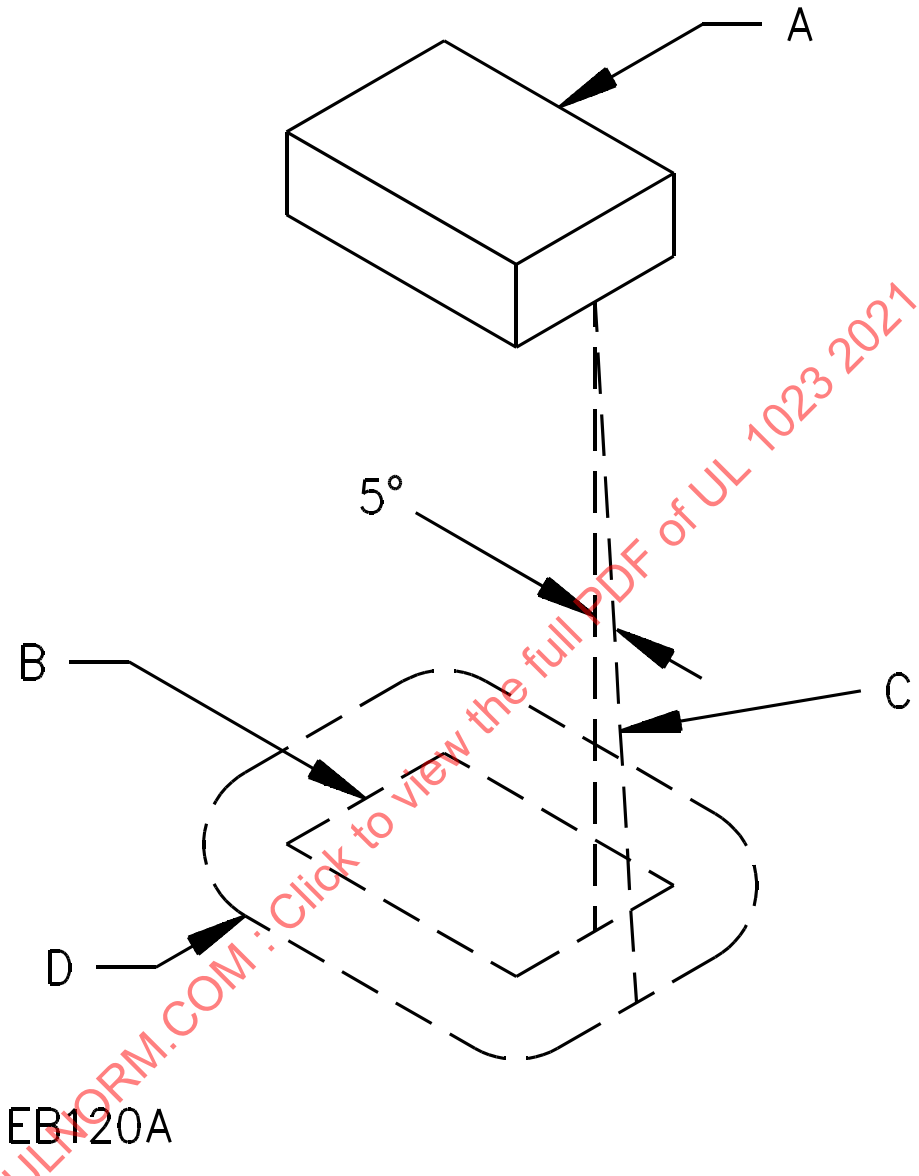
10.1.6 The requirement in 10.1.5 necessitates either a nonflammable bottom in accordance with 10.2.3, or a protective barrier as described in Figure 10.1 under all areas containing flammable materials.

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

10.1.7 A construction employing individual barriers under components, groups of components or assemblies, as specified in Figure 10.1, is to be considered as complying with the requirement in 10.1.6.

Figure 10.1

Protective pan



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.

10.2 Openings

10.2.1 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 10.2 for top cover designs and Figure 10.3 for side openings. See also 10.2.2.

Figure 10.2

Cross sections of top cover designs

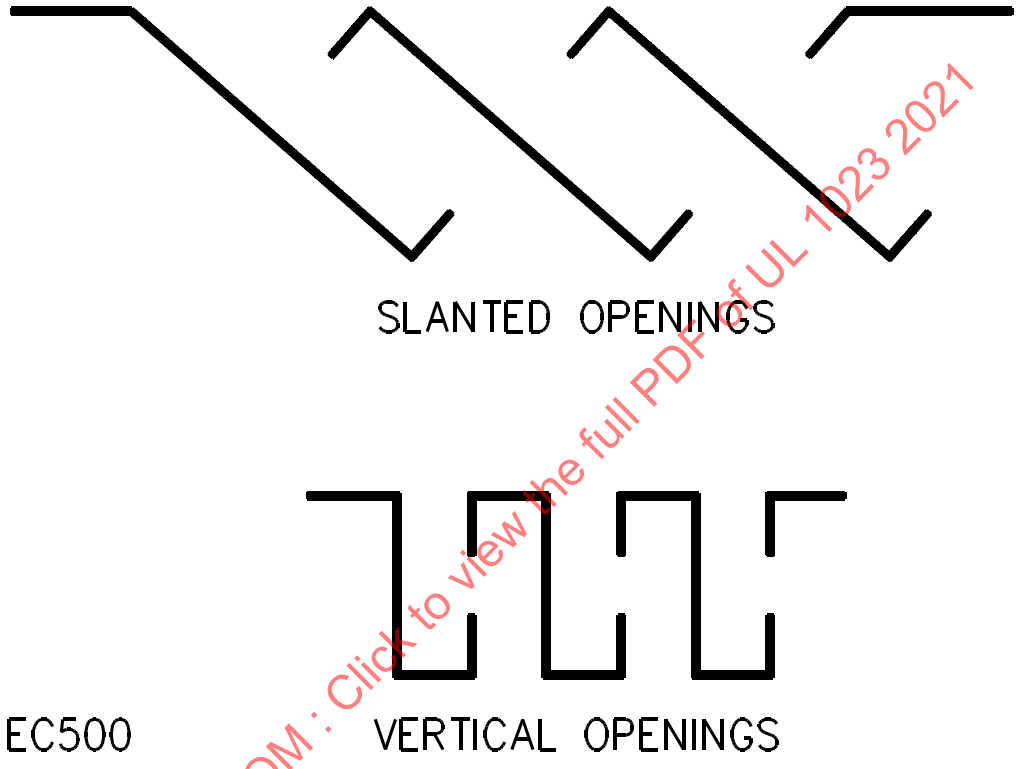
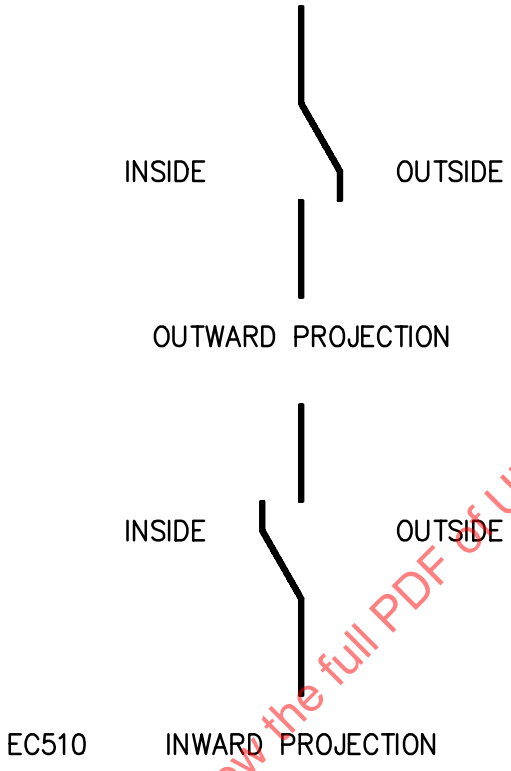


Figure 10.3

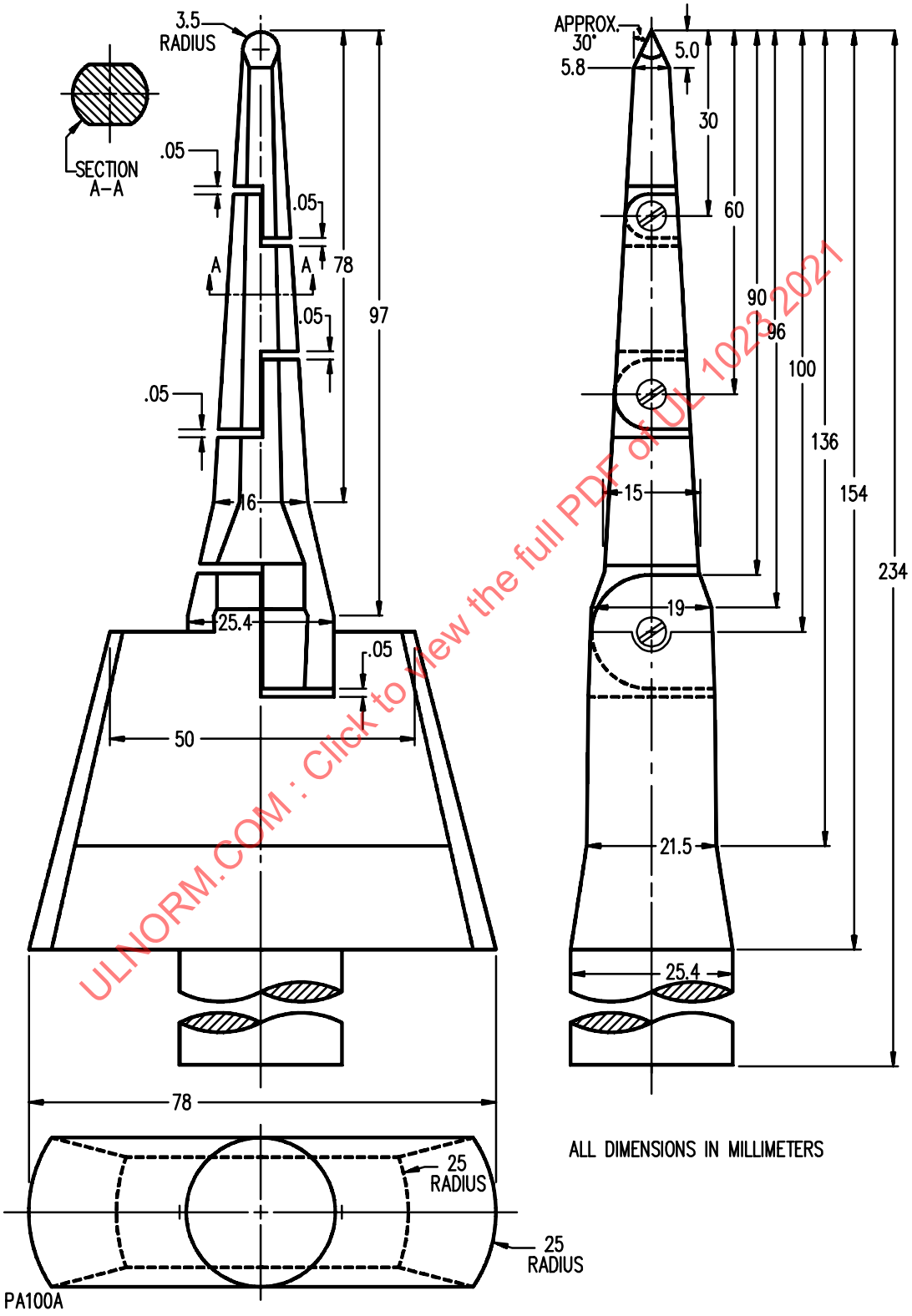
Louvers



10.2.2 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 10.4, cannot be made to contact any uninsulated live electrical part (other than low-voltage) or film coated wire when inserted through the opening in a straight or articulated position.

Figure 10.4

Probe



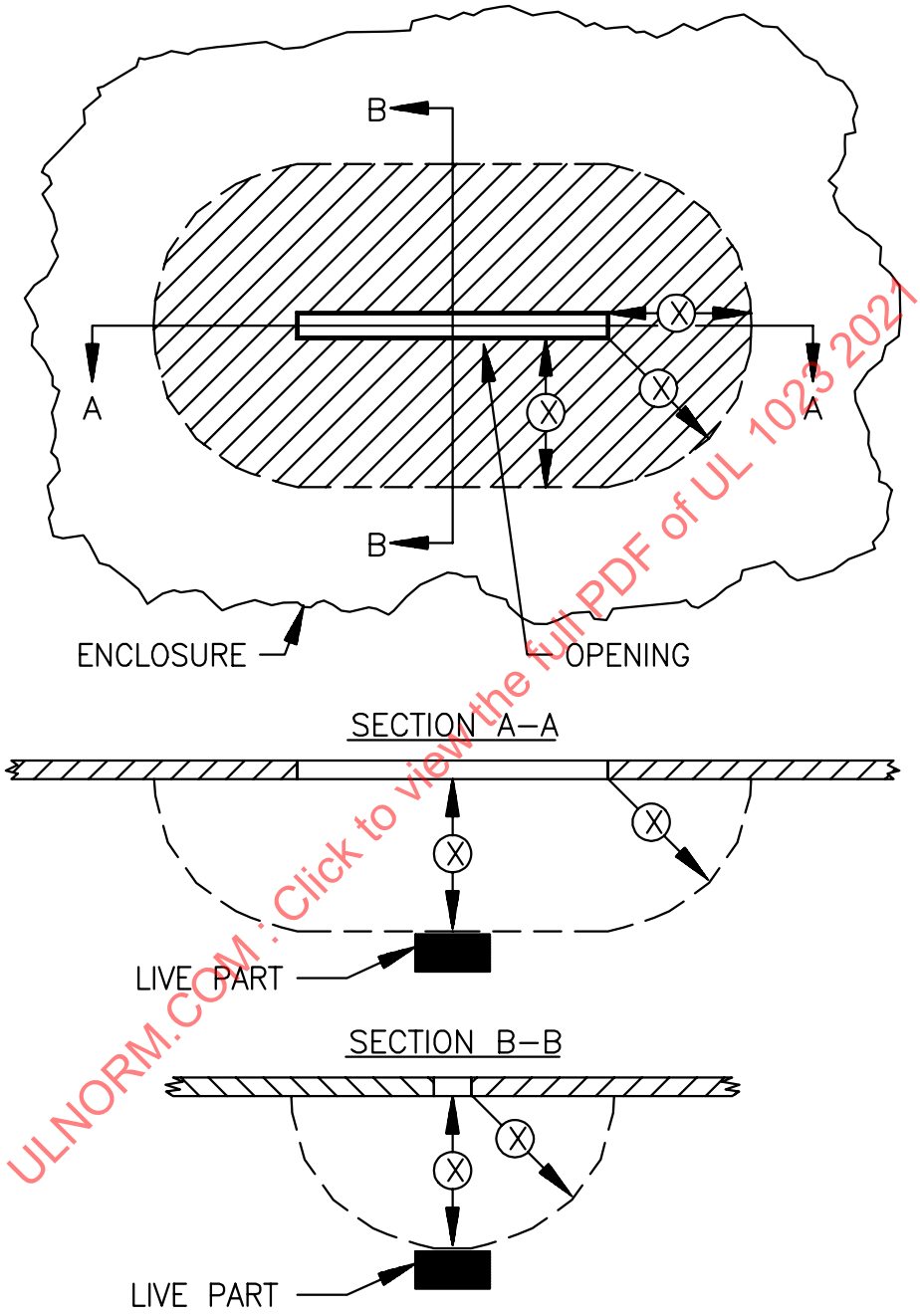
High-impact polystyrene articulate probes are available from Underwriters Laboratories Inc.

10.2.3 An opening that permits entrance of a 1 inch (25.4-mm) diameter rod is acceptable under the conditions described in Figure 10.5.

10.2.4 Openings may be provided in the bottom panels or protective pans under areas containing materials not classified at least V-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 10.6 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 58.

Figure 10.5

Openings over 1 inch (25.4 mm) wide



EC100A

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

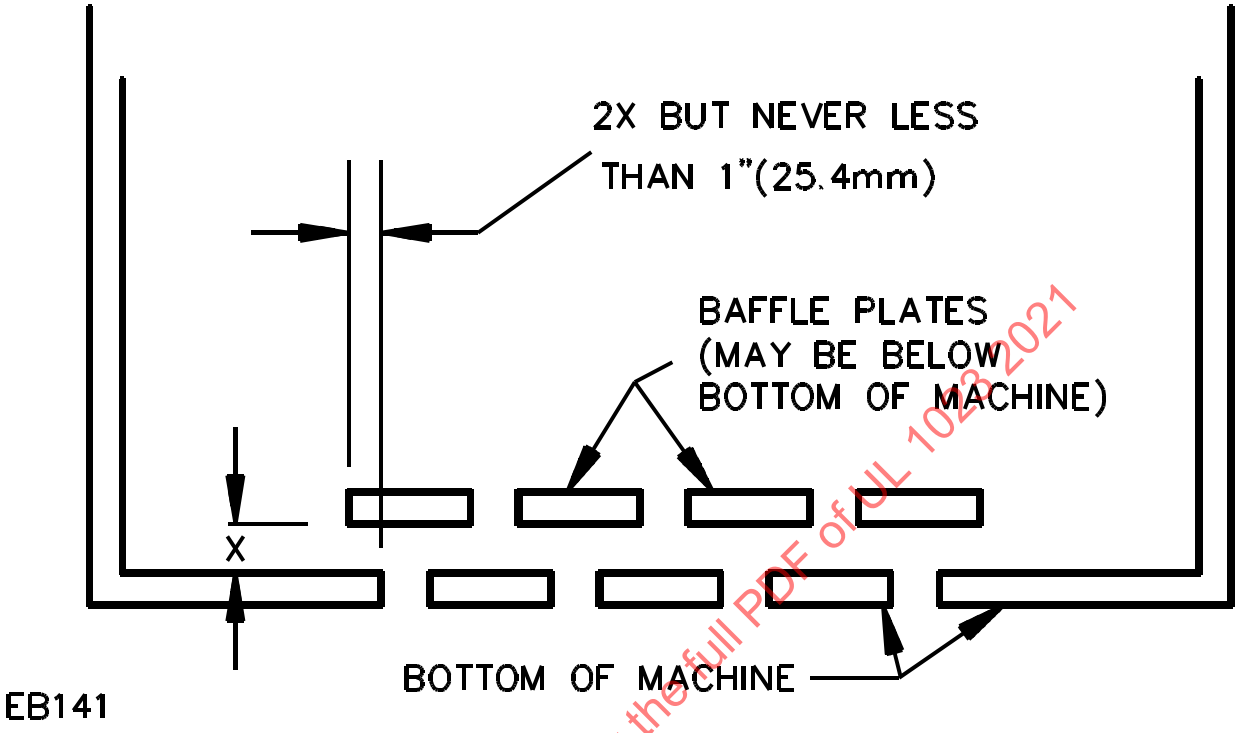
a) Less than X inches (mm) from the perimeter of the opening, as well as

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).

Figure 10.6

Baffle



10.2.5 The bottom of the enclosure under areas containing only materials classified as V-1 or less flammable may have openings not larger than 1/16 square inch (40.3 mm^2).

10.2.6 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.

10.3 Cast metal

10.3.1 The minimum thickness of cast metal for an enclosure shall be as indicated in Table 10.1.

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 56, and the Mechanical Strength Tests for Enclosures, Section 59.

10.4 Sheet metal

10.4.1 The thickness of sheet metal employed for the enclosure of a product shall be not less than that indicated in Table 10.2 or Table 10.3, 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 56, and the Mechanical Strength Tests for Enclosures, Section 59.

10.4.2 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.

10.5 Nonmetallic

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

10.5.2 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 53). See the Drop Test, Section 56, and the Mechanical Strength Tests for Enclosures, Section 59.

10.6 Doors, covers, and guards

10.6.1 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.

10.6.2 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.

10.7 Screens and expanded metal

10.7.1 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 mm^2) 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, General, Section 27), 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 cm^2) 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).

10.7.2 The wires of a screen shall be not less than 16 AWG (1.3 mm^2) steel if the screen openings are 1/2 square inch (323 mm^2) or less in area, and shall be not less than 12 AWG (2.1 mm^2) steel for larger screen openings.

11 Electric Shock

11.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See the Electric Shock Current Test, Section 38.

11.2 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.

11.3 The maximum value of 5.2 megohms mentioned in 11.2 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.

11.4 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.

12 Protection Against Corrosion

12.1 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.

12.2 The requirement of 12.1 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.

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

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

FIELD-WIRING CONNECTIONS

13 General

13.1 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.

13.2 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 6.4(b).

14 Cord-Connected Products

14.1 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.

14.2 The flexible cord shall be of Type SP-1, SPT-1, SP-2, SPT-2, SV, SVT, SJ, SJT, or equivalent, minimum 18 AWG (0.82 mm^2). It shall be rated for use at the voltage and current ratings of the appliance.

14.3 A cord with integral attachment plug shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817.

14.4 The attachment plug of the cord shall be a 2-blade polarized or 3-wire grounding type if the product has screw shell lampholders or a single pole switch or other single pole current interrupting device in the power circuit. The screw shell of a lampholder or similar device shall be in the grounded side of the circuit. Single pole current interrupting devices shall be in the ungrounded side of the circuit. See Polarity Identification, Section 17.

14.5 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.

14.6 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.

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

Exception: Products utilizing a secondary power source meeting the requirements of Section 49, Charging Current Test, and where loss of the AC primary power source results in annunciation of an audible trouble signal.

14.8 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 57.

14.9 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.

14.10 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.

15 Permanently-Connected Products

15.1 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.

15.2 A field wiring terminal shall comply with:

a) 15.4 and 15.6 – 15.10;

b) The field wiring requirements in the Standard for Electrical Quick-Connect Terminals, UL 310;

c) The requirements in the Standard for Wire Connectors, UL 486A-486B;

d) The Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E; or

e) The field wiring requirements (Code 2) in the Standard 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.

15.3 If leads are provided in lieu of wiring terminals, they shall be not less than 6 inches (152 mm) long, and not smaller than 22 AWG (0.32 mm^2) except that leads intended for connection of a line-voltage source shall be not smaller than 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 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 60.3 for strain relief, and

d) The installation instructions shall indicate that the lead shall not be spliced to a conductor larger than 18 AWG (0.82 mm^2).

15.4 Soldering lugs or solderless (pressure) wire connectors shall be used for 8 AWG (8.4 mm^2) and larger wires. For 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.

15.5 Wiring terminals shall be prevented from turning.

15.6 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 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 19 AWG (0.65 mm^2) or smaller conductor.

15.7 A wire binding screw shall thread into metal.

15.8 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 15.9.

15.9 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.

15.10 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.

16 Special Terminal Assemblies

16.1 Special wiring terminals shall be prevented from turning.

16.2 Any of the following terminal configurations may be employed for connection of field wiring if they comply with all of the requirements in 16.3.

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 (a) – (e).

16.3 Any of the terminal configurations listed in 16.2 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 22 AWG (0.32 mm^2).

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 60.

Exception: Terminals complying with the requirements in any of the standards specified in 15.2 (b) – (e) are not required to be subjected to the Special Terminal Assemblies Tests, Section 60.

17 Polarity Identification

17.1 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.

17.2 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 gray color and shall be distinguishable from the other leads.

18 General

18.1 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.

18.2 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.

18.3 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.

18.4 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.

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

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

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

18.8 A printed wiring assembly shall comply with the Standard for Printed-Wiring Boards, UL 796.

19 Separation of Circuits

19.1 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. See 19.3.

19.2 The thickness of a metal barrier shall not be less than the specified value as required by 10.1, 10.2, or 10.3, 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).

19.3 When Class 2, Class 3, and power-limited fire alarm circuit conductors occupy the same enclosure as electric light, power, Class 1, or nonpower-limited fire alarm circuit conductors, both of the following conditions shall be met:

a) The enclosure shall provide a minimum of two conductor entry openings so that the Class 2, Class 3, power-limited fire alarm circuit conductors may be segregated from electric light, power, Class 1, and nonpower-limited fire alarm circuit conductors. The installation document shall completely detail the entry routing of all conductors into the enclosure.

b) The enclosure shall be constructed so that, with all field-installed wiring connected to the product, a minimum of 1/4 inch (6.4 mm) spacing is provided between all Class 2, Class 3, and power-limited fire alarm circuit conductors and all electric light, power, Class 1, and nonpower-

limited fire alarm circuit conductors. Compliance with this requirement may be achieved by specific wire routing configurations that are detailed in the installation document. If a wire routing scheme will not maintain a separation of 1/4 inch (6.4 mm), barriers shall be used to provide separation.

Exception: This requirement need not apply when all circuit conductors operate at 150 volts or less to ground, and:

a) The Class 2, Class 3, and power-limited fire alarm circuits are installed using CL3, CL3R, or CL3P, or substitute cable permitted by the National Electrical Code, ANSI/NFPA 70, and the Class 2, Class 3, and power-limited fire alarm circuit conductors extending beyond the cable jacket are separated a minimum of 1/4 inch or by nonconductive tubing or by a nonconductive barrier from all other conductors or

b) The Class 2, Class 3, and power-limited fire alarm circuit conductors are installed as a Class 1 or higher circuit.

20 Bonding for Grounding

20.1 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 21.

20.2 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.

20.3 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.

20.4 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 20.9. A separate bonding conductor shall be installed so it is protected from mechanical damage.

20.5 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.

20.6 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 20.5.

20.7 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 20.5.

20.8 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.

20.9 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 20.1.

20.10 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 20.1.

Table 20.1
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.

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

21 Equipment Grounding Connection

21.1 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.

21.2 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.

21.3 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.

21.4 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.

ELECTRICAL COMPONENTS

22 General

22.1 Mounting of parts

22.1.1 Uninsulated high- or low-voltage live parts shall be secured to their supporting surfaces so that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings to less than those indicated under Spacings, General, Section 27.

22.1.2 Friction between surfaces is not acceptable as a means to prevent turning, loosening, or shifting of a part as required in 22.1.1. A lock washer that provides both spring take-up and an interference lock or equivalent means is acceptable as a means to prevent turning.

22.2 Current-carrying parts

22.2.1 A current-carrying part shall be of metal such as silver, copper, a copper alloy, or equivalent.

22.2.2 Bearings, hinges, and the like are not acceptable for use as current-carrying parts.

22.3 Capacitors

22.3.1 A capacitor shall not be affected by the temperatures to which it may be subjected under the most severe conditions of intended use.

22.4 Overcurrent protection

22.4.1 If primary circuit breakers or fuses are provided, their rating shall be in accordance with the maximum input to the product.

22.5 Semiconductors

22.5.1 Semiconductors shall be rated for the intended application under all environmental conditions to which they may be exposed in service. See the Performance Tests, Sections 28 – 56.

22.6 Switches

22.6.1 A switch provided as part of the product shall have a current and voltage rating not less than that of the circuit which it controls when the product is operated under any condition of intended service. If the circuit controlled has a power factor less than 75 percent, the switch shall have a horsepower rating (judged on the basis of the ampere equivalent) or a rating of not less than 200 percent of the maximum load current.

22.7 Secondary power supply

22.7.1 The use of a secondary power supply is optional. If a secondary power supply is provided, such as a battery, it shall be of sufficient capacity to supply the maximum intended power to the system for 4 hours in the standby condition and thereafter be able to operate the control unit for burglar-alarm signals for at least 4 minutes continuously. See 89.13.

22.7.2 If a standby battery is used, provision shall be made for an automatic test of the standby battery at least once every 24 hours. The test shall be conducted under a load sufficient to determine if the battery requires service, has been removed or is disconnected. A battery requiring service is defined as a battery which is not capable of providing 4 minutes of alarm during a power failure. If the automatic battery test determines that the battery requires service or is disconnected, an audible trouble signal shall be provided.

Exception: The trouble signal may be visual if it is provided at that part of the system where arming and/or disarming is performed.

23 Insulating Materials

23.1 General

23.1.1 Materials used as a base for the support of live parts shall be of a flame-resistant, moisture-resistant insulating material, such as porcelain, phenolic or cold-molded composition, or the equivalent.

23.1.2 A base mounted on a metal surface shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base that are not staked, upset, sealed, or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

23.1.3 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not for the sole support of live parts where shrinkage, current leakage, or warping of the fiber may introduce a risk of fire or electric shock.

23.1.4 A countersunk sealed live part shall be covered with a waterproof insulating compound that will not melt at a temperature 15°C (27°F) higher than the maximum intended operating temperature of the assembly, and at not less than 65°C (149°F) in any case. The depth or thickness of sealing compound shall be not less than 1/8 inch (3.2 mm).

23.1.5 The thickness of a flat sheet of insulating material, such as phenolic composition or the equivalent, employed for panel-mounting of parts shall be not less than that indicated in Table 23.1.

Table 23.1
Thickness of flat sheets of insulating material

Maximum dimensions				Minimum thickness,[a]	
Length or width,		Area,			
inch	(cm)	inch^2	(cm^2)	inch	(mm)
24	(60.9)	360	(2323)	3/8[a]	(9.5)
48	(122)	1152	(7432)	1/2	(12.7)
48	(122)	1728	(11148)	5/8	(15.9)

Table 23.1 Continued on Next Page

Table 23.1 Continued

Maximum dimensions				Minimum thickness,[a]	
Length or width,		Area,			
inch	(cm)	inch^2	(cm^2)	inch	(mm)
Over 48	(122)	Over 1728	(11148)	3/4	(19.1)

[a] Material less than 1/8 inch (3.2 mm) in thickness may be employed for a panel if the panel is adequately supported or reinforced to provide rigidity not less than that of a 3/8 inch (9.5 mm) sheet. Material less than 1/8 inch may be employed for subassemblies, such as supports for terminals for internal wiring, resistors, and other components.

23.2 Bushings

23.2.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent which shall provide a smooth, rounded surface against which the cord may bear.

23.2.2 If the cord hole is in phenolic composition or other nonconducting material, or in metal not less than 0.042 inch (1.07 mm) thick, a smooth, rounded surface is considered to be the equivalent of a bushing.

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

23.2.4 Fiber may be employed where it will not be subjected to a temperature higher than 90°C (194°F) under intended operating conditions if the bushing is not less than 3/64 inch (1.2 mm) thick and will not be exposed to moisture.

23.2.5 An insulating-metal grommet is acceptable in lieu of an insulating bushing, provided that the insulating material used is not less than 1/32 inch (0.8 mm) thick and completely fills the space between the grommet and the metal in which it is mounted.

24 Batteries

24.1 Batteries included as part of a product shall be located and mounted so that terminals of adjacent cells will be prevented from coming in contact with each other or with metal parts of the enclosure as a result of shifting of the batteries.

24.2 A battery compartment intended for use with rechargeable batteries that emit gases during charging shall be provided with vent holes that do not exceed the requirements of 10.2.2 – 10.2.6.

24.3 The mounting arrangement shall permit ready access to the battery compartment to facilitate battery replacement without disassembly of any part of the product except for a cover or door.

24.4 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs), and provided with strain relief.

24.5 The conditions of use shall provide for equalization of cells when two or more cells are used in series or parallel. The method shall comply with the battery manufacturer's specifications.

24.6 The conditions of storage shall comply with the battery manufacturer's specifications with regard to position, temperature, and state-of-charge.

24.7 If the battery is of a type that will lose capacity as a result of long periods of inactivity, provision shall be made for cycling of the battery to prevent the condition or for a method of detecting the existence of a capacity loss.

24.8 As used in the product, all conditions of battery discharge shall comply with the battery manufacturer's specifications with regard to rate of discharge and automatic voltage cutoff if required to prevent polarity reversal or damage.

24.9 To determine compliance with these requirements, the household burglar-alarm system unit manufacturer shall provide all specifications, information, and calculations necessary to determine that a battery is used within its specifications and confirm that the charging method used complies with the battery manufacturer's specifications under all conditions of intended use. The conditions of intended use are to include overvoltage and undervoltage conditions as described in the Undervoltage Operation Test, Section 33, and the Overvoltage Operation Test, Section 34, in all combinations with the temperature variations described in the Variable Ambient Temperature Test, Section 35.

24.10 If required by local, state or federal ordinances or regulations for disposal reasons, rechargeable type batteries shall be removable.

25 Lampholders and Lamps

25.1 Lampholders and lamps shall be rated for the circuit in which they are employed.

25.2 The screw-shell of an Edison-base lampholder employed in the supply circuit operating at high voltage shall be connected to the conductor identified as the grounded conductor.

25.3 If more than one Edison-base lampholder is provided, the screw-shells of all such lampholders shall be connected to the same conductor for products operating at high voltage.

25.4 A lampholder shall be constructed or installed so that uninsulated high-voltage live parts, other than the screw-shell, will not be exposed to contact by persons removing or replacing lamps.

26 Transformers, Coils, and Relays

26.1 A transformer shall be of the two-coil or insulated type.

Exception: An autotransformer may be employed provided that the terminal or lead common to both input and output circuits is identified, and the output circuits are located only within the enclosure containing the autotransformer. See 17.1.

26.2 A coil shall be treated with an insulating varnish, or the equivalent, and baked or otherwise impregnated to exclude moisture.

26.3 Film-coated or equivalently coated wire is not required to be given additional treatment to reduce the risk of moisture absorption.

SPACINGS

27 General

27.1 Spacings between uninsulated live parts and between uninsulated live parts and dead metal parts shall be not less than those indicated in 27.2 – 27.6.

27.2 The spacing between an uninsulated live part and

a) A wall or cover of a metal enclosure,

b) A fitting for conduit or metal-clad cable, and

c) A metal piece attached to a metal enclosure, where deformation of the enclosure is likely to reduce spacings,

shall be not less than those specified in Table 27.1.

Table 27.1
Minimum spacings

Point of application	Minimum spacings[a, b]				
	Voltage range[d], volts	Through air, inch	(mm)	Over surface, inch	(mm)
To walls of enclosure:					
Cast metal enclosures	0 – 300	1/4	(6.4)	1/4	(6.4)
Sheet metal enclosures	0 – 50	1/4	(6.4)	1/4	(6.4)
	51 – 300	1/2	(12.7)	1/2	(12.7)
Installation wiring terminals:[b]					
With barriers	0 – 30	1/8	(3.2)	3/16	(4.8)
	31 – 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)
Without barriers	0 – 30	3/16	(4.8)	3/16	(4.8)
	31 – 150	1/4	(6.4)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)
Special application installation wiring terminals, except solder-type terminals (see 13.2)	0 – 30	1/8	(3.2)	1/8	(3.2)
	31 – 150	3/16	(4.8)	3/16	(4.8)
	151 – 300	1/4	(6.4)	1/4	(6.4)
Rigidly clamped assemblies:[c]					
100 volt-amperes maximum	0 – 30	1/32[e]	(0.8)	1/32[e]	(0.8)
Other parts, except motors	0 – 30	3/64	(1.2)	3/64	(1.2)
	31 – 150	1/16	(1.6)	1/16	(1.6)
	151 – 300	3/32	(2.4)	3/32	(2.4)
Other parts					
	0 – 30	1/16	(1.6)	1/8	(3.2)
	31– 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)

Table 27.1 Continued on Next Page

Table 27.1 Continued

Point of application	Minimum spacings[a, b]				
	Voltage range[d], volts	Through air, inch	(mm)	Over surface, inch	(mm)

[a] An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material used where spacings would otherwise be insufficient, shall not be less than 0.028 inch (0.71 mm) thick; except that a liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through-air spacing required. The liner shall be located so that it will not be affected adversely by arcing. Insulating material having a thickness less than that specified may be used if it is suitable for the particular application.

[b] Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. The wire shall not be smaller than 18 AWG (0.82 mm^2).

[c] Rigidly clamped assemblies include such parts as contact springs on relays or cam switches, printed-wiring boards, and the like.

[d] These are rms values. Equivalent direct current or peak voltages 42.4 volts for 30 volts rms, 212 volts for 150 volts rms, and 424 volts for 300 volts rms.

[e] Spacings less than those indicated are permitted for printed-wiring board traces of circuits involving integrated circuits and similar components where the spacing between adjacent connecting wires on the component is less than 1/32 inch (0.8 mm).

27.3 The spacings between an uninsulated live part and

a) An uninsulated live part of opposite polarity,

b) An uninsulated grounded dead metal part other than the enclosure, and

c) An exposed dead metal part that is isolated (insulated)

shall be not less than those indicated in Table 27.1. See also 27.5 and 27.6.

27.4 If a short circuit between uninsulated high- or low-voltage live parts of the same polarity would prevent the intended signaling operation of the product without simultaneously producing an alarm signal, the spacings betweens such parts shall be not less than those indicated for other parts in Table 27.1.

27.5 Film-coated wire is considered an uninsulated live part in determining compliance of a product with the spacing requirements, but film coating is acceptable as turn-to-turn insulation in coils.

27.6 Minimum values of spacings are not specified for a semiconductor or relay socket, a semiconductor, a relay, a potentiometer, and like components used in electronic circuits. Spacings in such components shall:

a) Comply with the requirements of 27.3 – 27.5 or

b) Be such that the circuit complies with the Dielectric Voltage-Withstand Test, Section 46.

PERFORMANCE

GENERAL

28 Common Requirements

28.1 Test units and data

28.1.1 Household burglar-alarm system units that are fully representative of production units are to be used for each of the following tests unless otherwise specified.

28.1.2 The devices employed for testing are to be those specified by the wiring diagram of the product. However, substitute devices may be used if they produce functions and load conditions equivalent to those obtained with the devices intended to be used with the product in service.

28.2 Test samples and miscellaneous data

28.2.1 The following samples are to be provided for testing:

a) Two or more assembled system units of each type.

b) Unassembled samples of any encapsulated or otherwise permanently assembled portions which otherwise could not be disassembled for examination and photographs.

c) Installation and operating instructions of each sample (see 7.1).

28.2.2 Unless specifically noted otherwise, the test voltage for each test of a product is to be as specified in Table 28.1 and at the rated frequency.

Table 28.1
Voltages for tests

Rated voltage, nameplates	Test voltage
110 to 120	120
220 to 240	240
Other	Marked rating

29 Operation Test

29.1 A household burglar-alarm system unit shall operate for all conditions of its intended performance when employed in conjunction with initiating devices and indicating devices to form a system combination of the type indicated by the installation wiring diagram and any supplementary information provided.

29.2 Indicating devices and initiating devices are to be connected as specified by the installation wiring diagram to form a typical combination, and the product is then to be operated for each condition of its intended performance.

29.3 The initiating devices, door contacts, floor mats, intrusion detection units, and the like, employed for testing are to be those specified by the installation wiring diagram. However, substitute devices may be used if they produce equivalent signal indication and circuit loading. Substitute load devices are considered to be those that have been found by investigation to provide the same load conditions as those obtained with the devices intended to be used with the product in service.

29.4 If a product is to be mounted in a specified position in order to function as intended, it shall be tested in that position.

29.5 Power-input supply terminals are to be connected to supply circuits of rated voltage and frequency. See 28.2.2.

29.6 A product under test shall be in the intended circuit condition and ready for its intended signaling operation when it is connected to related devices and circuits as specified in 29.1 – 29.5.

29.7 The protection circuit may be either an open circuit or closed circuit or a combination of the two. The circuits shall be fully supervised and an open in the circuit shall result in either an alarm or trouble signal. The operation of a detection device, such as a switch or motion detector, shall result in an alarm.

Exception: Supervision is not required for an initiating device circuit of a Grade A system control unit extending not more than 3 feet (0.91 m) from the control unit or not more than 3 feet from a device (transmitter) that provides the required supervised transmission of an alarm signal at the control unit provided that a test feature or procedure is incorporated to test the operability of the circuit and the 3-foot distance does not include an intervening barrier such as a wall or ceiling. See 89.1(h).

29.8 The system shall be arranged so that an alarm initiated from protective circuits cannot be stopped by removing the cause thereof.

29.9 A transmitter, or other device, that sends or relays a signal from an initiating device to a control unit, and that is powered from a nonrechargeable (primary) battery, shall transmit the signal when the initiating device is activated. After each transmission sequence, a transmitter, or other device used with a motion detector, may shut down for a maximum period of 3 minutes before transmitting the next sequence in order to conserve the battery.

29.10 Provision shall be made for the user to conveniently test the operability of the product each time it is placed on duty.

29.11 An alarm silencing switch, if provided separately from an on-off switch, shall provide a visual signal indicating that the system is silenced.

29.12 A reset switch, if provided separately from an on-off switch, shall be of the momentary action self-restoring type.

29.13 The system shall not reset if the cause of the alarm has not been cleared.

29.14 A time delay provision for egress shall not exceed 120 seconds.

29.15 A time delay used to prevent an alarm during entrance shall not exceed 15 seconds.

29.16 If a system requires a key or code to turn it off, the time delay before an alarm is initiated may be extended to a maximum of 45 seconds.

29.17 The number of key changes or codes available shall be not less than 300.

29.18 A system of the type described in 29.16 shall be provided with a tamper contact or the equivalent, that will cause an immediate alarm if the key or code control is opened in an attempt to defeat the system. See 29.19.

29.19 Tampering with a remote key or code control outside the protected area shall cause an alarm.

29.20 Manually operated switches used to initiate the system shall be guarded to prevent unintentional operation.

29.21 The sounding device shall operate continuously for at least 4 minutes. The audible signal may have an automatic cutoff to prevent its sounding an alarm longer than 4 minutes.

Exception: If the alarm is initiated by a device intended to detect the presence of an intruder in the area of its coverage, such as a motion detector, the audible signal may be cut off automatically in less than 4 minutes, but not less than 1 minute.

29.22 In a system used in conjunction with a fire-alarm system, the audible alarm for burglary shall be distinct from the audible alarm for fire. The fire alarm audible shall be in accordance with the Standard for Household Fire Warning System Units, UL 985.

29.23 If a trouble signal is used, it shall be distinct from an alarm signal, but in a combination system the same trouble signal may be employed for both burglar-alarm and nonburglar-alarm circuits.

29.24 Any additional types of signals, such as basement flooding, shall be distinctive from burglary and fire, but may use the trouble signals.

29.25 If the primary source of electric power is commercial power, a "power on" indicator of the visible type shall be provided.

29.26 Neither loss nor restoration of commercial power shall cause an alarm signal.

30 Electrical Supervision Test

30.1 An open in the primary supply of an ac-powered household burglar-alarm system unit shall be shown by de-energization of the "power on" indicator.

30.2 An open or ground fault in any circuit extending from a household system unit, other than the initiating device circuit, shall not affect the operation of the product except for the loss of the function extending from that circuit.

Exception: If such a fault will affect the operation of the product, a trouble signal or alarm condition or test feature that will indicate the fault is required.

30.3 A fault condition, open ground, or short of other than a burglar-alarm circuit of a combination control unit, shall not affect the burglar-alarm signal.

30.4 If a silencing means, such as a switch, is provided to de-energize the audible trouble signal, actuation of the silencing means shall be indicated by a trouble light or equivalent visual indication.

31 Input Test

31.1 Input circuit

31.1.1 The input of a product shall not exceed the marked current, power, or volt-ampere rating by more than 10 percent when the product is operated under all conditions of use while connected to a rated source of supply in accordance with the requirements in 31.1.2.

31.1.2 The test voltage for this test is to be the maximum rated voltage for the product. For a product having a single voltage rating, such as 115 volts, maximum rated voltage is to be that single voltage. If the voltage is given in terms of a range of voltages, such as 110 – 120 volts, the maximum rated voltage is the highest value of the range.

31.2 Output circuit

31.2.1 The measured voltage of all output circuits shall be within 85 and 110 percent of their marked rating under the following conditions:

a) With primary power connected and varied from 85 percent to 110 percent of rated voltage. If a standby battery is used, a fully charged battery shall be connected.

b) With primary power connected and varied from 85 percent to 110 percent of rated voltage. If a standby battery is used, it shall be disconnected.

c) If a standby battery is used, the product shall be tested with the primary power disconnected. The standby battery shall be replaced with a variable voltage filtered DC power supply and the voltage varied from 85 percent to 110 percent of rated battery voltage.

31.2.2 Measurements shall be made with no load or with the minimum load that is specified by the manufacturer. If more than one output circuit is provided, all circuits shall have no load connected to the minimum load that is specified by the manufacturer connected to each circuit.

31.2.3 Upon completion of 31.2.2, measurements shall then be made with the maximum load connected to the output circuit. If more than one output circuit is provided, all circuits shall have the maximum load connected. If connecting the maximum load to each output circuit will exceed the total output capacity of the product, the output circuit to be measured shall be loaded to its maximum rating and the other output circuits shall have their load adjusted so that the maximum output capacity of the product is reached. This shall be repeated for each test.

31.2.4 Rated load is that value of resistive load which causes the rated current to flow when the load is connected to the output circuit and the input voltage to the product is adjusted to its rated voltage.

32 Power-Limited Circuits

32.1 General

32.1.1 All field-wiring circuits that derive energy from power sources connected to a control unit shall be classified as a power-limited or nonpower-limited circuit. A circuit shall be considered nonpower-limited unless otherwise identified in the installation documentation and marking on the product.

32.1.2 The power source (or sources) supplying a power-limited circuit shall be either:

a) Inherently limited requiring no overcurrent protection or

b) Limited by a combination of a power source and overcurrent protection devices, such that a power-limited circuit has electrical characteristics described in Table 32.1 for AC circuits or Table 32.2 for DC circuits.

Table 32.1
Power source limitations for alternating current Class 2 and Class 3 circuits

Power source type	Circuit voltage V_{max}[a], (volts)	Power source maximum nameplate ratings		Current limitations I_{max}[b], (amps)	Power limitations $(VA)_{max}$[c], (volt-amps)	Maximum over-current protection, (amps)
		VA, (volt-amps)	Current, (amps)			
Inherently limited power source (overcurrent protection not required)						
Class 2	0 to 20	$(5.0)V_{max}$	5.0	8.0	–	–
	over 20 to 30	100	$100/V_{max}$	8.0	–	–
	over 30 to 150	$(0.005)V_{max}$	0.005	0.005		
Class 3	over 30 to 100	100	$100/V_{max}$	$150/V_{max}$	–	–
Not inherently limited power source (overcurrent protection required)						
Class 2	0 to 20	$(5.0)V_{max}$	5.0	$1000/V_{max}$	250[d]	5.0
	over 20 to 30	100	$100/V_{max}$	$1000/V_{max}$	250	$100/V_{max}$
Class 3	over 30 to 100	100	$100/V_{max}$	$1000/V_{max}$	250	$100/V_{max}$
	over 100 to 150	100	$100/V_{max}$	1.0	N.A.	1.0

NOTES

1 Adapted from the National Electrical Code (ANSI/NFPA 70), copyright National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2 For nonsinusoidal AC, V_{max} shall not be greater than 42.4 volts peak. Where wet contact (immersion not included) is likely to occur, Class 3 wiring methods shall be used, or V_{max} shall not be greater than 15 volts for sinusoidal AC and 21.2 volts peak for nonsinusoidal AC.

[a] V_{max}: Maximum output voltage regardless of load with rated input applied.

[b] I_{max}: Maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed, if used. When a transformer limits the output current, I_{max} limits apply after one minute of operation. Where a current limiting impedance is used in combination with a nonpower-limited transformer or a stored energy source, such as a storage battery, in order to limit the output current, I_{max} limits apply after 5 seconds.

[c] $(VA)_{max}$: Maximum volt-ampere output after one minute of operation regardless of load, and with overcurrent protection bypassed, if used.

[d] If the power source is a transformer, $(VA)_{max}$ is 350 volt-amperes or less where V_{max} is 15 volts or less.

Table 32.2
Power source limitations for direct current Class 2 and Class 3 circuits

Power source type	Circuit voltage V_{max}[a] (volts)	Power source maximum nameplate ratings		Current limitations I_{max}[b] (amps)	Power limitations $(VA)_{max}$[c] (volt-amps)	Maximum over-current protection, (amps)
		VA, (volt-amps)	Current, (amps)			
Inherently limited power source (overcurrent protection not required)						
Class 2	0 to 20	$5.0V_{max}$	5.0	8.0	–	–
	over 20 to 30	100	$100/V_{max}$	8.0	–	–
	over 30 to 60	100	$100/V_{max}$	$150/V_{max}$	–	–

Table 32.2 Continued on Next Page

Table 32.2 Continued

Power source type	Circuit voltage V_{max}[a] (volts)	Power source maximum nameplate ratings		Current limitations I_{max}[b] (amps)	Power limitations $(VA)_{max}$[c] (volt-amps)	Maximum over-current protection, (amps)
		VA, (volt-amps)	Current, (amps)			
	over 60 to 150	$0.005V_{max}$	0.005	0.005	–	–
Class 3	over 60 to 100	100	$100/V_{max}$	$150/V_{max}$	–	–
Not inherently limited power source (overcurrent protection required)						
Class 2	0 to 20	$5.0V_{max}$	5.0	$1000/V_{max}$	250[d]	5.0
	over 20 to 60	100	$100/V_{max}$	$1000/V_{max}$	250	$100/V_{max}$
Class 3	over 60 to 100	100	$100/V_{max}$	$1000/V_{max}$	250	$100/V_{max}$
	over 100 to 150	100	$100/V_{max}$	1.0	N.A.	1.0

NOTES

1 Adapted from the National Electrical Code (ANSI/NFPA 70), copyright National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2 A dry cell battery shall be considered an inherently limited power source, provided the voltage is 30 volts or less and the capacity is equal to or less than that available from series connected No. 6 carbon zinc cells.

3 For DC interrupted at a rate of 10 to 200 hertz, V_{max} shall not be greater than 24.8 volts. Where wet contact (immersion not included) is likely to occur, Class 3 wiring methods shall be used, or V_{max} shall not be greater than 30 volts for continuous DC and 12.4 volts for DC that is interrupted at a rate of 10 to 200 hertz.

[a] V_{max}: Maximum output voltage regardless of load with rated input applied.

[b] I_{max}: Maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed, if used. When a transformer limits the output current, I_{max} limits apply after one minute of operation. Where a current limiting impedance is used in combination with a nonpower-limited transformer or a stored energy source, such as a storage battery, in order to limit the output current, I_{max} limits apply after 5 seconds.

[c] $(VA)_{max}$: Maximum volt-ampere output after one minute of operation regardless of load, and with overcurrent protection bypassed, if used.

[d] If the power source is a transformer, $(VA)_{max}$ is 350 volt-amperes or less where V_{max} is 15 volts or less.

32.1.3 With regard to 32.1.2, means that may be used for current limiting include:

a) Transformer winding impedance;

b) A thermal link embedded within the winding overwrap of a transformer;

c) Circuit components (resistors, regulators, transistors, and the like) that comply with the Temperature Test, Section 48, under I_{max} condition; and

d) Current limiting impedances determined to be suitable for the application (positive temperature coefficient varistor or the like).

Circuit component burnout, permanent (by soldered means or the like) or replaceable fuses, opening of conductors on printed wiring boards, or opening of internal wiring conductors shall not be used as a means of current limiting.

32.1.4 The overcurrent protection device specified in 32.1.2 shall be of the noninterchangeable type such that it cannot be renewed in the field with an overcurrent device having a higher current rating.

32.1.5 If the product contains a float battery charger, the V_{max}, I_{max}, and VA_{max} are to be measured with both the AC power source and the battery connected to the product. If the circuit contains a battery transfer relay or a trickle charge battery circuit, the V_{max}, I_{max}, and VA_{max} are to be measured first with the

product energized only from the AC power source and then measured a second time with the product energized solely from the battery. The battery used during these measurements is to have the largest capacity specified in the manufacturer's installation document and is to be charged for a period of time that will result in the battery being fully charged for this test.

32.1.6 When measuring I_{max} and VA_{max}, all overcurrent protection devices of the control unit are to be short-circuited. However, current limiting devices are not to be bypassed and are to remain functional.

32.2 Maximum voltage

32.2.1 With the circuit energized only from its rated primary power source, the output voltage of the circuit under test is to be measured while the circuit is connected to full rated load and under open circuit conditions. The maximum voltage under these two conditions is to be considered V_{max}. If the product incorporates a secondary source of supply, the test is to be repeated with the circuit energized solely from the secondary power source and with the primary source disconnected. The V_{max} value obtained from each power source is to be considered separately when applying the requirements in Table 32.1 or Table 32.2.

32.3 Maximum current

32.3.1 In order to determine compliance with the I_{max} limitation, a variable load resistor is to be connected across the circuit. While monitoring the current through the load resistor, the load resistor is to be adjusted from open circuit to short circuit as quickly as possible and the highest current noted. The load resistor is then to be readjusted to produce the highest current obtained and the current through the load resistor is to be measured after 1 minute or after 5 seconds as determined by Table 32.1 or Table 32.2.

32.3.2 If the maximum current through the load resistor cannot be maintained for 5 seconds due to current limiting devices (opening of thermal link, power supply foldback, PTC varistor affect, and the like), the circuit load resistor is to be adjusted to a value that will produce a current just above the I_{max} value indicated in Table 32.1 or Table 32.2. The results are acceptable if the I_{max} value stated in Table 32.1 or Table 32.2 cannot be maintained for more than 5 seconds.

32.3.3 If a transformer limits the value of I_{max}, and if I_{max} cannot be maintained for 1 minute due to transformer burnout, a plot of current versus time is to be generated and the graph extrapolated to 1 minute. The results are acceptable if the extrapolated value of I_{max} at 1 minute does not exceed the I_{max} limitations as indicated in Table 32.1 or Table 32.2.

32.4 VA_{max} (not inherently limited circuits only)

32.4.1 The circuit is to be energized from a rated source of supply and then the circuit under test open-circuited. A variable load resistor, initially set to draw rated circuit current, is then to be connected across the circuit. The circuit voltage and current are to be recorded and the load is to be removed. The resistance of the load is then to be decreased, momentarily reconnected across the circuit while recording the voltage and current, and then removed. This procedure is to be repeated until the load resistance has been reduced to a short circuit. Using the recorded voltage and current, the maximum volt-ampere, VA_{max}, output under each load condition is to be calculated. The load resistor is then to be adjusted to that value which produced the maximum volt-ampere, VA_{max}, calculated and then connected to the circuit. After 1 minute, the voltage and current are again to be measured. The results of this test are acceptable if the calculated volt-ampere, VA, output of the circuit after 1 minute does not exceed the values specified in Table 32.1 or Table 32.2, as appropriate.

33 Undervoltage Operation Test

33.1 A household burglar-alarm system unit shall operate for its intended signaling performance while energized at 85 percent of its rated voltage.

33.2 If a standby battery is employed, the reduced voltage value is to be computed on the basis of the rated nominal battery voltage.

33.3 A product that uses batteries for principal power or standby power shall be tested for operation at 60 percent of nominal battery voltage if supplied by primary batteries, or 85 percent of nominal battery voltage if supplied by secondary batteries.

33.4 If the maximum impedance of an initiating device circuit extending from a product is required to be less than 100 ohms in order to obtain intended operation, the specified maximum impedance is to be connected to the circuit during this test. If no impedance limitation is indicated in Markings, Details, Section 89, an impedance of 100 ohms is to be employed in the initiating device circuit.

34 Overvoltage Operation Test

34.1 A household burglar alarm system unit shall operate continuously for its intended signaling performance while energized at 110 percent of its rated supply voltage, and shall operate continuously during the normal supervisory condition at the same voltage.

34.2 A product that uses batteries for either principal or standby power is to be tested for operation at 110 percent of intended battery voltage, whether the batteries are primary or secondary types.

35 Variable Ambient Temperature Test

35.1 A household burglar-alarm system unit intended for indoor use shall operate as intended while energized at rated voltage with its related equipment connected as intended, during and immediately following 4 hours exposure to ambient temperatures of 0 and 49°C (32 and 120°F).

35.2 A product intended for outdoor use shall operate as intended during and immediately following 4 hours exposure to ambient temperatures of minus 35 and plus 66°C (minus 30 and plus 150°F).

36 Humidity Test

36.1 A household burglar-alarm system unit shall function as intended during and immediately following exposure for 24 hours to air having a relative humidity of 85 ±5 percent at a temperature of 30 ±2°C (86 ±3°F).

36.2 Cord-connected products powered from a high-voltage source following the 24-hour exposure to the humid environment shall comply with the Leakage Current Test for Cord-Connected Products, Section 37.

37 Leakage Current Test for Cord-Connected Products

37.1 The leakage current of a cord-connected product intended to be located in an area accessible to contact by a person, or a cord-connected product that is interconnected to a product that is accessible to contact by a person, shall not exceed the values shown in Table 37.1 when tested in accordance with 37.7 and 37.9 after exposure to the Humidity Test, Section 36.

Exception: Products that incorporate a loss-of-ground detector that dependably opens the live conductors need not comply with these requirements.

Table 37.1
Maximum leakage current

Type of product	Maximum leakage current, mA
Two-wire, cord-connected product	0.50
Three-wire (including grounding conductor), cord-connected, portable product	0.50
Three-wire (including grounding conductor), cord-connected, stationary or fixed product	0.50

37.2 The product is to be de-energized, removed from the humidity environment, placed on a dry insulating surface, and immediately re-energized from a rated source of supply in accordance with 28.2.2. Leakage current measurements are to be made with the product in the normal supervisory and operating conditions.

37.3 As used in these requirements, leakage currents are all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces and ground or other exposed conductive surfaces.

37.4 All exposed conductive surfaces are to be tested for leakage currents. Where these surfaces are simultaneously accessible, leakage currents are to be measured from these surfaces to the grounded supply conductor individually, as well as collectively, and from one surface to another. Parts are considered to be exposed surfaces unless enclosed in a manner that reduces the risk of electric shock. Surfaces are to be considered simultaneously accessible if they can be readily contacted simultaneously by one or both hands of a person.

37.5 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured by using metal foil with an area of 100 by 200 millimeters (3.9 by 7.8 inches) in contact with the surface. The surface is less than 100 by 200 millimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the product.

37.6 The measurement circuit for leakage current is to be as illustrated in Figure 37.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument and need not have all of the attributes of the defined instrument.

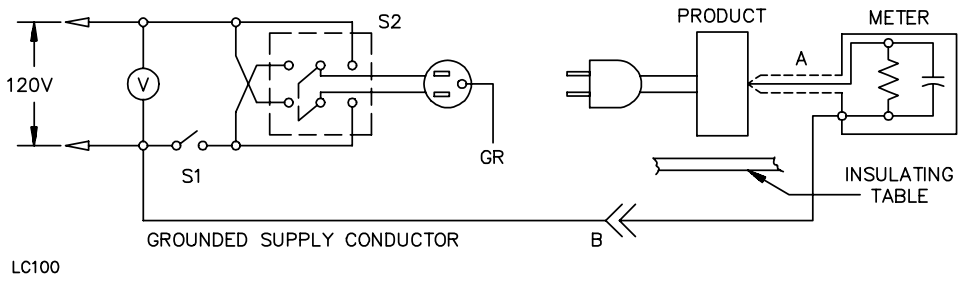
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

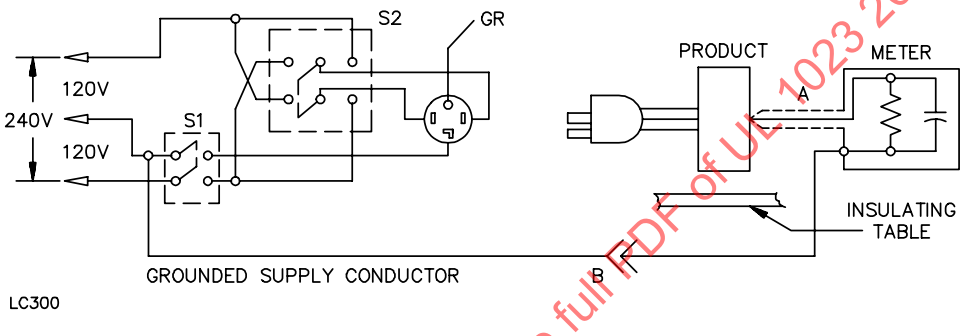
c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At indications of 0.5 and 0.75 milliamperes, the measurement is to have an error of not more than 5 percent.

Figure 37.1

Leakage current measurement circuits



(1) – Product intended for connection to a 120- or 208-volt power supply.



(2) – 240- or 208-volt product intended for connection to 3-wire, grounded-neutral power supply.

A – Probe with shielded lead – under some circumstances where higher frequency components are present, shielding of measuring instrument and its leads may be necessary.

B – Separated and used as clip when measuring currents from one part of a product to another.

37.7 A sample of the product is to be prepared and conditioned for leakage current measurement as follows:

a) The sample is to be representative of the wiring methods, routing, component location and installation, and the like, of the product.

b) The grounding conductor is to be open at the attachment plug and the test product isolated from ground.

c) The sample is to be conditioned as described in 36.1.

37.8 The test is to be conducted as soon as possible after the completion of the Humidity Test, Section 36, and the supply voltage is to be adjusted to the test voltage.

37.9 The leakage current test sequence with reference to the measuring circuit in Figure 37.1, is to be as follows:

a) With switch S1 open, the product is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2. All manual switching devices then are to be operated as intended and leakage currents measured using both positions of switch S2.

b) With the product switching devices in their operating positions, switch S1 then is to be closed, energizing the product and within a period of 5 seconds the leakage current is to be measured using both positions of switch S2. All manual switching devices then are to be operated as intended and leakage currents measured using both positions of switch S2.

c) The product switching devices then are to be returned to their operating positions and the product allowed to operate until thermal equilibrium is obtained. Leakage current is to be monitored continuously. For this test, thermal equilibrium is defined as that condition where leakage current is found to be either constant or decreasing in value. Both positions of switch S2 are to be used in determining this measurement.

d) Immediately following the test, any single-pole switch on the product is to be opened, and the leakage current monitored until constant or decreasing values are recorded. Readings are to be taken in both positions of switch S2.

38 Electric Shock Current Test

38.1 If the open circuit potential between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part, exceeds 42.4 volts peak, the part shall comply with the requirements of 38.2– 38.4, as applicable.

38.2 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 38.1 when the resistor is connected between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part.

Table 38.1
Maximum current during operator servicing

Frequency, hertz[a]	Maximum current through a 500-ohm resistor, milliamperes peak
0 – 100	7.1
500	9.4

Table 38.1 Continued on Next Page

Table 38.1 Continued

Frequency, hertz[a]	Maximum current through a 500-ohm resistor, milliamperes peak
1,000	11.0
2,000	14.1
3,000	17.3
4,000	19.6
5,000	22.0
6,000	25.1
7,000 or more	27.5

[a] Linear interpolation between adjacent values may be used to determine the maximum acceptable current corresponding to frequencies not shown. The table applies to repetitive nonsinusoidal or sinusoidal waveforms.

38.3 The duration of a transient current flowing through a 500-ohm resistor connected as described in 38.2 shall not exceed:

a) The value determined by the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I} \right)^{1.43}$$

in which:

I is the peak current in milliamperes

T is the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 milliamperes and the time that the current falls below 7.1 milliamperes for the last time, and

b) 809 milliamperes, regardless of duration.

The interval between occurrences shall be equal to or greater than 60 seconds if the current is repetitive. Typical calculated values of maximum acceptable transient current duration are shown in Table 38.2.

Table 38.2
Maximum transient current duration

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak
7.1	7.26 seconds
8.5	5.58
10.0	4.42
12.5	3.21
15.0	2.48
17.5	1.99
20.0	1.64
22.5	1.39
25.0	1.19

Table 38.2 Continued on Next Page

Table 38.2 Continued

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak
30.0	919 milliseconds
40.0	609
50.0	443
60.0	341
70.0	274
80.0	226
90.0	191
100.0	164
150.0	92
200.0	61
250.0	44
300.0	34
350.0	27
400.0	23
450.0	19
500.0	16
600.0	12
700.0	10
809.0	8.3

38.4 The maximum capacitance between the terminals of a capacitor that is accessible during operator servicing shall comply with the following equations:

$$C = \frac{88{,}400}{E^{1.43}(\ln E - 1.26)} \quad \text{for } 42.4 \le E \le 400$$

$$C = 35{,}288E^{-1{,}5364} \quad \text{for } 400 \le E \le 1000$$

in which:

C is the maximum capacitance of the capacitor in microfarads and

E is the potential in volts across the capacitor prior to discharge.

E is to be measured 5 seconds after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like. Typical calculated values of maximum capacitance are shown in Table 38.3.

Table 38.3
Electric shock – stored energy

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
1000	0.868
900	1.02
800	1.22
700	1.50
600	1.90
500	2.52
400	3.55
380	3.86
360	4.22
340	4.64
320	5.13
300	5.71
280	6.40
260	7.24
240	8.27
220	9.56
200	11.2
180	13.4
160	16.3
140	20.5
120	26.6
100	36.5
90	43.8
80	53.8
70	68.0
60	89.4
50	124.00
45	150.00
42.4	169.00

38.5 With reference to the requirements of 38.2 and 38.3, the current is to be measured while the resistor is connected between ground and:

a) Each accessible part individually or

b) All accessible parts collectively if the parts are simultaneously accessible.

The current also is to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

38.6 If the product has a direct-current rating, measurements are to be made with the product connected in turn to each side of a 3-wire, direct-current supply circuit.

38.7 Current measurements are to be made with any operating control, or adjustable control that is subject to user operation, in all operating positions, and either with or without a vacuum tube, separable connector, or similar component in place. These measurements are to be made with controls placed in the position that causes maximum current flow.

39 Overload Test

39.1 General

39.1.1 A household burglar-alarm system unit other than that operating from a primary battery shall operate as intended after being subjected to 50 cycles of alarm signal operation at a rate adjusted to 15 cycles per minute with the supply circuit to the product at 115 percent of the rated test voltage. Each cycle is to begin with the product energized in the normal supervisory condition, followed by initiation of an alarm, and then restoration to normal supervisory condition.

39.1.2 Rated test loads are to be connected to those output circuits of the product that are energized from the product power supply, such as remote indicators, relays, and the like. The test loads are to be those devices, or the equivalent, intended for connection to the product. If an equivalent load is employed for a normally inductive load, the equivalent load is to have a power factor of 60 percent. The rated loads are to be established with the product connected initially to a rated source of supply, in accordance with 28.2.2, following which the voltage is to be increased to 115 percent of rating.

39.1.3 For DC signaling circuits, an equivalent inductive test load is to have the required DC resistance for the test current, and the inductance is to be calibrated to obtain a power factor of 60 percent while connected to a 60-hertz AC rms potential equal to the rated DC test voltage. When the inductive load has both the required DC resistance and the required inductance, the current drawn from the AC source will be 0.6 times the current drawn from the DC source.

39.2 Separately energized circuits

39.2.1 Separately energized circuits of a product, such as dry contacts, shall operate as intended after being subjected to 50 cycles of alarm signal operation at a rate of not more than 15 cycles per minute (as defined in 39.1.1) while connected to a source of supply in accordance with 28.2.2, and with 150 percent rated loads at 60 percent power factor applied to output circuits that do not receive energy from the product.

39.2.2 The test loads are to be set at 150 percent of rated current while connected to a separate source of supply in accordance with 28.2.2.

40 Endurance Test

40.1 General

40.1.1 A household burglar-alarm system unit shall operate as intended while connected to a source of supply in accordance with 28.2.2, with rated loads connected to the product, and following 6000 cycles of setting, tripping, and restoration at a rate of not more than 15 cycles per minute.

40.2 Separately energized circuits

40.2.1 Separately energized circuits that do not receive energy from the product shall operate as intended following 6000 cycles of signal operation at a rate of not more than 15 cycles per minute while connected to a source of supply in accordance with 28.2.2, and with a rated load 60 percent power factor applied to the output circuits.

41 Jarring Test

41.1 A household burglar-alarm system unit shall withstand jarring resulting from impact and vibration anticipated in the intended application, without causing signaling operation of any part and without impairing subsequent intended operation of the unit.

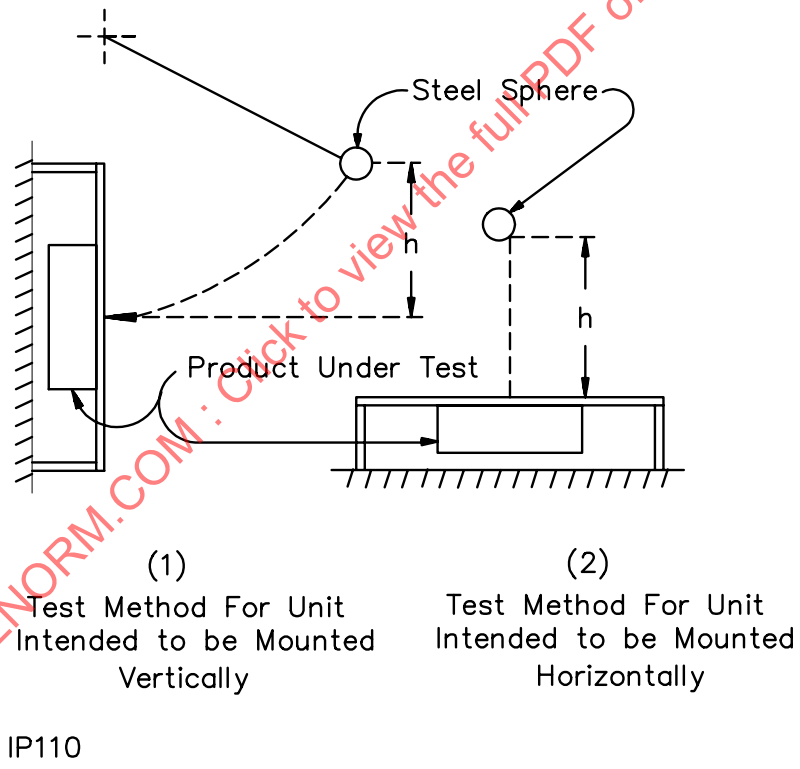
41.2 The product and associated equipment is to be mounted as intended to the center of a 6- by 4-foot (1.8- by 1.2-m), nominal 3/4-inch (19.1-mm) thick plywood board secured in place at four corners. A 3-foot-pound (4.08-J) impact is to be applied to the center of the reverse side of this board by means of a 1.18-pound (0.54-kg), 2-inch (50.8-mm) diameter steel sphere either:

a) Swung through a pendulum arc from a height of 30.5 inches (775 mm) or

b) Dropped from a height of 30.5 inches, depending upon the mounting of the equipment. See Figure 41.1.

Figure 41.1

Jarring test



41.3 The product is to be mounted in its intended position and jarred while the unit is in the normal supervisory condition and connected to a rated source of supply in accordance with 28.2.2. Following the jarring, the product shall be tested for its intended operation.

42 Vibration Test

42.1 A household burglar-alarm system unit shall withstand vibration without breakage or damage to parts. Following the vibration, the product shall operate for its intended signaling operation.

42.2 A sample is to be secured in its intended mounting position on a mounting board and the board, in turn, securely fastened to a variable speed vibration machine having an amplitude of 0.01 inch (0.25 mm). The frequency of vibration is to be varied from 10 to 35 hertz in increments of 5 hertz until a resonant frequency is obtained. The sample then is to be vibrated at the maximum resonant frequency for a period of 1/4 hour. If no resonant frequency is obtained, the sample is to be vibrated at 35 hertz for a period of 4 hours.

42.3 For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from a position of rest or one-half of the total table displacement. Resonance is defined as a magnification of the applied vibration.

43 Dust Test

43.1 The intended operation of a household burglar-alarm system unit intended for use outdoors shall not be impaired by an accumulation of dust.

43.2 A sample in its intended mounting position is to be placed de-energized in an airtight chamber having an internal volume of at least 3 cubic feet (0.02 m^3).

43.3 Approximately 2 ounces (0.06 kg) of cement dust, maintained at an ambient room temperature of approximately 23 ±2°C (73.4 ±3°F) at 20 – 50 percent relative humidity and capable of passing through a 200-mesh screen (see Specification for Wire Cloth Sieves for Testing Purposes, ASTM E11-81), is to be circulated for 15 minutes by means of compressed air or a blower so as to completely envelop the sample in the chamber. The air flow is to be maintained at an air velocity of approximately 50 feet per minute (0.25 m/s).

43.4 Following the exposure to dust, the product is to be removed, mounted in its intended position, energized from a source of supply in accordance with 28.2.2, and tested for compliance with the requirements of the Operation Test, Section 29.

44 Component Malfunction Test

44.1 Malfunctioning of an electronic component, such as opening or shorting of a capacitor, either shall not impair the intended operation or shall be indicated by a trouble or alarm signal. See 9.2.

45 Rain Test

45.1 The section of equipment intended to be exposed to weather shall withstand a rain exposure for 1 hour without producing a risk of electric shock or affecting its intended operation. The test shall not result in the entrance of water into enclosures above the lowest electrical component other than insulated wire or in wetting live parts.

Exception: Water may enter an enclosure above the lowest electrical component if the point of entrance is not in proximity to live parts and live parts are not wetted during the rain exposure.

45.2 Electrical components are to be energized during this test, and the unit tested under the conditions most likely to cause the entrance of water into or onto electrical components. It may be necessary to operate the unit under various modes of operation or to de-energize the unit if more water entry could result. Each exposure is to be for 1 hour, and if more than one exposure is required, the unit is to be prepared for testing as indicated in 45.4 before repeating the test.

45.3 Field wiring connections are to be made in accordance with the wiring method specified for the unit. Openings intended to terminate conduit are to be sealed. Openings intended for the entry of a conductor (s) for a low-voltage circuit are not to be sealed unless seals are provided as a part of the product.

45.4 The unit is to be examined to determine that all electrical parts are not wetted and that there is no accumulation of water within the enclosures of electrical parts prior to rain exposure. Also see 45.5.

45.5 Drying of the unit prior to the second or subsequent exposure is not required if, without such preparation, the unit complies with the requirement in 45.6.

45.6 After each exposure, the unit shall have an insulation resistance between live parts and dead metal parts not less than 50,000 ohms. The insulation resistance is to be measured 1 minute after application of the voltage obtained by using the method described in 45.7, or equivalent means, and a DC circuit. After measurement of the insulation resistance, the complete unit is to comply with the requirements of the Dielectric Voltage-Withstand Test, Section 46.

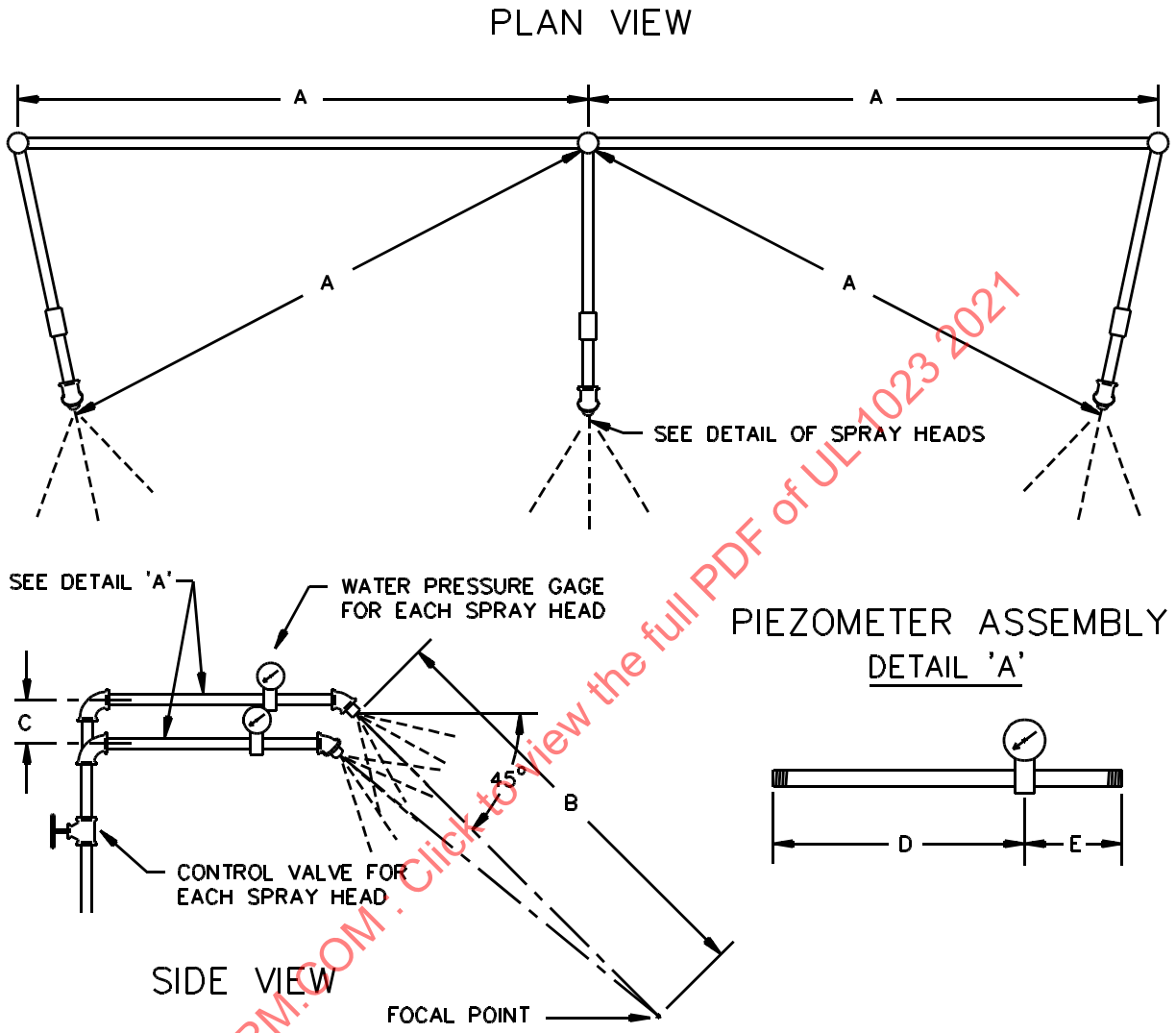
45.7 Insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms used in conjunction with a 250-volt, direct-current source.

45.8 The rain test apparatus is to consist of three spray heads mounted in a water supply rack as shown in Figure 45.1. Spray heads are to be constructed in accordance with Figure 45.2. The water pressure for all tests is to be maintained at 5 psi (34.5 kPa) at each spray head. The unit is to be brought into the focal area of the three spray heads in such position and under such conditions that the greatest quantity of water will enter the unit. The spray is to be directed at an angle of 45 degrees to the vertical toward the louvers or other openings closest to live parts.

45.9 Before the test is started, the resistivity of the water is to be no more than 3675 ohm-centimeters, measured at 25°C (77°F). At the conclusion of the test, the resistivity of the water is to be no more than 3800 ohm-centimeters at 25°C.

Figure 45.1

Rain-test spray head piping

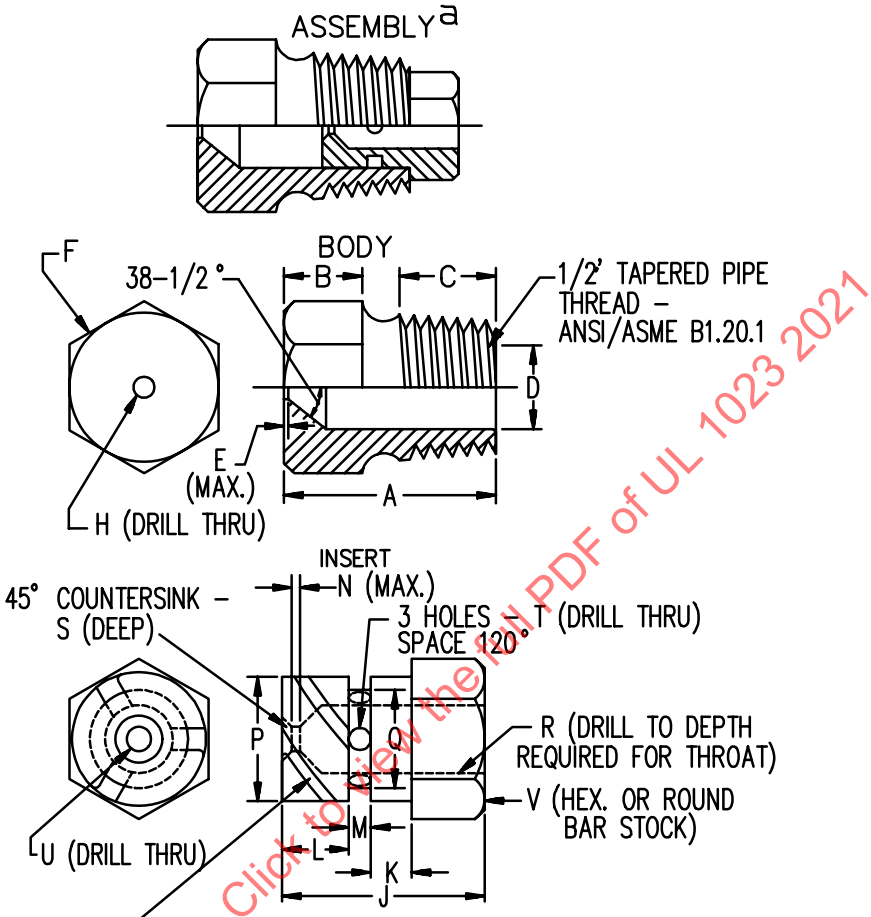


Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

RT101E

Figure 45.2

Rain-test spray head



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35)[b]	2.80
H	(No.9)[b]	5.0	U	(No. 40)[b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

RT100E

46 Dielectric Voltage-Withstand Test

46.1 A household burglar-alarm system unit shall withstand for 1 minute, without breakdown, the application of an essentially sinusoidal AC potential of a frequency within the range of 40 – 70 hertz, or a DC potential, between live parts and the enclosure, live parts and exposed dead metal parts, and live parts of circuits operating at different potentials or frequencies. The test potential is to be (also, see 46.2):

a) For a unit rated 30 volts AC rms (42.4 volts DC or AC peak) or less – 500 volts (707 volts, if a DC potential is used).

b) For a unit rated between 31 and 250 volts AC rms – 1000 volts (1414 volts, if a DC potential is used).

c) For a unit rated more than 250 volts AC rms – 1000 volts plus twice the rated voltage (1414 volts plus 2.828 times the rated AC rms voltage, if a DC potential is used).

46.2 For the application of a potential in accordance with 46.1, the voltage is to be the applicable value specified in 46.1 (a), (b), or (c), based on the highest voltage of the circuits under test instead of the rated voltage of the household burglar-alarm system unit. Electrical connections between the circuits are to be disconnected before the test potential is applied.

46.3 Exposed dead metal parts referred to in 46.1 are noncurrent-carrying metal parts that are likely to become energized and accessible from outside of the enclosure of a unit during intended operation with the door of the enclosure closed.

46.4 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an AC test potential in accordance with 46.1(c) is to be applied directly to all wiring involving more than 250 volts.

46.5 If the charging current through a capacitor or capacitor type filter connected across the line, or from line to earth ground, is sufficient to prevent maintenance of the specified AC test potential, the capacitor or filter is to be tested using a DC test potential in accordance with 46.1.

46.6 The test potential may be obtained from any convenient source having sufficient capacity to maintain the specified voltage. The output voltage of the test apparatus is to be monitored. Starting at zero, the potential is to be increased at a rate of approximately 200 volts per minute until the required test value is reached and is to be held at that value for 1 minute.

46.7 A printed wiring assembly or other electronic circuit component that would be damaged by the application of, or would short-circuit, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. A representative subassembly may be tested instead of an entire household burglar-alarm system unit. Rectifier diodes in the power supply may be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

46.8 A printed-wiring assembly employing insulating coatings or encapsulation, shall comply with the requirements of the 46.1 – 46.7, before and after being treated. If it is impractical to use untreated samples, finished samples shall comply with the requirements of the dielectric voltage-withstand test, after they are subjected to the Humidity Test, Section 36, the Temperature Test, Section 48, and other applicable tests described in this standard. Electrical connections between circuits being tested are to be disconnected before testing.

47 Static Discharge Test

47.1 The components of a household burglar-alarm system unit shall be shielded so that the unit's operation is not impaired, or a false alarm obtained, when subjected to static electric discharge. CAUTION: Potentially Lethal Voltages Are Involved – Use Safety Precautions.

47.2 Each of two products is to be mounted in its intended mounting position on a 3/4 inch (19.1 mm) thick unpainted exterior grade plywood surface and connected to a source of supply in accordance with 28.2.2. If a product is intended to be installed on a metal electrical junction box, the box is to be connected to earth ground. A series combination of a 250-picofarad low leakage capacitor, rated 20,000 volts DC minimum, and a 1500-ohm resistor, is to be connected to two high-voltage insulated leads, 3 feet (0.9 m) long, and stripped 1 inch (25.4 mm) at each end. The end of each lead is to be attached to a 1/2 inch (12.7 mm) diameter metal test probe with a spherical end mounted on an insulating rod. The capacitors are to be charged by touching the ends of the test leads to a source of 10,000 volts DC for at least 2 seconds for each discharge.

47.3 Ten discharges are to be applied to different points on the exposed surface of the product, and the capacitors are to be recharged prior to each discharge. Five discharges are to be made with one lead connected to earth ground and the other lead brought into contact with the product surface, followed by five discharges with the polarity reversed.

47.4 Following the discharges, the product shall comply with the requirements of the Operation Test, Section 29.

48 Temperature Test

48.1 The materials employed in the construction of a household burglar-alarm system unit shall not attain temperature rises greater than those indicated in Table 48.1.

48.2 The values for temperature in Table 48.1 are based on an assumed ambient temperature of 25 ±15° C (77 ±27°F), and tests are to be conducted at an ambient temperature within that range. A temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than at 5-minute intervals, indicate no change.

Table 48.1
Maximum temperature rises

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
A. COMPONENTS				
1. Capacitors:[c,d]				
a) Electrolytic type	25	(45)	40	(72)
b) Other types	25	(45)	65	(117)
2. Rectifiers – at any point				
a) Germanium	25	(45)	50	(90)
b) Selenium	25	(45)	50	(90)
c) Silicon				

Table 48.1 Continued on Next Page

Table 48.1 Continued

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
(1) Maximum 60 percent of rated volts	50	(90)	75	(135)
(2) 61 percent or more of rated volts	25	(45)	75	(135)
3. Relay, solenoid, transformer and other coils with:				
a) Class 105 insulation system:				
Thermocouple method	25	(45)	65	(117)
Resistance method	35	(63)	75	(135)
b) Class 130 insulation system:				
Thermocouple method	45	(81)	85	(153)
Resistance method	55	(99)	95	(171)
c) Class 155 insulation system:				
(1) Class 2 transformers:				
Thermocouple method	95	(171)	95	(171)
Resistance method	115	(207)	115	(207)
(2) Power transformers:				
Thermocouple method	110	(198)	110	(198)
Resistance method	115	(207)	115	(207)
d) Class 180 insulation system:				
(1) Class 2 transformers:				
Thermocouple method	115	(207)	115	(207)
Resistance method	135	(243)	135	(243)
(2) Power transformers:				
Thermocouple method	125	(225)	125	(225)
Resistance method	135	(243)	135	(243)
4. Resistors:[c]				
a) Carbon	25	(45)	50	(90)
b) Wire wound	50	(90)	125	(225)
c) Other	25	(45)	50	(90)
5. Solid state devices	see note d			
6. Other components and materials:				
a) Fiber used as electrical insulation or cord bushings	25	(45)	65	(117)
b) Varnished cloth insulation	25	(45)	60	(108)
c) Thermoplastic materials	Rise based on temperature limits of the material			
d) Phenolic composition used as electrical insulation or as parts where failure will result in risk of fire or electric shock[e]	25	(45)	125	(225)
e) Wood or other combustibles	25	(45)	65	(117)
f) Sealing compound	15°C (27°F) less than the melting point			
g) Fuses	25	(45)	65	(117)
B. CONDUCTORS				

Table 48.1 Continued on Next Page

Table 48.1 Continued

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
1. Appliance wiring material[f]	25°C (45°F) less than the temperature limit of the wire			
2. Flexible cord (for example, SJO, SJT)	35	(63)	35	(63)
3. Conductors of field-wired circuits to be permanently connected to the product	35	(63)	35	(63)
C. GENERAL				
1. All surfaces of the product and surfaces adjacent to or upon which the product may be mounted	65	(117)	65	(117)
2. Surfaces intended to be contacted by the user in operating the unit (control knobs, push buttons, levers, and the like):				
a) Metal	35	(63)	35	(63)
b) Nonmetallic	60	(108)	60	(108)
3. Surfaces subjected to casual contact by the user (enclosure, grille, and the like):				
a) Metal	45	(81)	45	(81)
b) Nonmetallic	65	(117)	65	(117)

[a] For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure may be not more than 65°C (117°F).

[b] A capacitor that operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating.

[c] The temperature rise of a resistor may exceed the values shown if the power dissipation is 50 percent or less of the manufacturer's rating.

[d] The temperature of a solid-state device (for example, transistor, SCR, integrated circuits) shall not exceed 50 percent of its rating during the normal standby condition. The temperature of a solid-state device shall not exceed 75 percent of its rated temperature under the alarm condition or any other condition of operation which produces the maximum temperature dissipation of its components. For reference purposes 0°C (32°F) shall be considered as 0 percent. For integrated circuits, the loading factor shall not exceed 50 percent of its rating under the normal standby condition and 75 percent under any other condition of operation. Both solid-state devices and integrated circuits may be operated up to the maximum ratings under any one of the following conditions:

1) The component complies with the requirements of MIL-STD-883E.

2) A quality-control program is established by the manufacturer consisting of inspection and test of 100 percent of all components, either on an individual basis, as part of a subassembly, or equivalent.

3) Each assembled production unit is subjected to a burn-in test, under the condition which results in the maximum temperatures, for 24 hours while connected to a source of rated voltage and frequency in an ambient of at least 49°C (120°F) followed by recalibration of the sensitivity and retested.

[e] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds which have been investigated and found to have special heat-resistant properties.

[f] For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code; the maximum allowable temperature rise in any case is 25°C (45°F) less than the temperature limit of the wire in question.

48.3 Temperatures are to be measured by means of thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2), except that the temperature of a coil may be measured by either the thermocouple or change-in-resistance method. However, the thermocouple method is not to be employed for a temperature measurement at any point where supplementary thermal insulation is employed.

48.4 The temperature of a coil winding may be determined by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature by means of the formula:

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

Δt is the temperature rise in degrees C;

R is the resistance in ohms at the end of test;

r is the resistance in ohms at the start of test;

k is 234.5 for copper, or 225 for electrical conductor grade aluminum;

t_1 *is the room temperature at start of test in degrees C; and*

t_2 *is the room temperature at end of test in degrees C.*

48.5 If referee temperature measurements are necessary, thermocouples consisting of 30 AWG (0.06 mm^2) iron and constantan wires and a potentiometer-type indicating instrument are to be used.

48.6 The product is to be connected to a supply circuit of rated voltage and frequency in accordance with 28.2.2 and operated continuously under representative service conditions that are likely to produce the highest temperature.

48.7 If a current-regulating resistor or reactor is provided as a part of a unit, it is to be adjusted for the maximum resistance or reactance at its intended current.

48.8 The test is to be continued until:

a) Constant temperatures are attained during the normal supervisory condition and

b) One hour has elapsed during the intended alarm signaling condition of a unit designed to produce a continuous signal until it is restored to the supervisory condition.

49 Charging Current Test

49.1 General

49.1.1 This test is to be conducted in conjunction with the Temperature Test, Section 48, on products provided with standby batteries. The product shall operate as intended during this test.

49.2 Discharged battery

49.2.1 The measured voltage of an output circuit with a battery discharged as specified in 49.2.2 – 49.2.4 shall not be less than 85 percent of the marked rating of the output circuits.

49.2.2 The battery is first to be charged by applying AC input power to the product for 48 hours, during which the product is to be operated continuously with the normal standby load connected. AC input is then to be disconnected, and terminal voltage of the battery is to be measured one minute after disconnection.

49.2.3 The battery is then to be discharged by maintaining the normal standby load connected to the output for 4 hours or the marked standby time.

49.2.4 At the conclusion of the discharge period, maximum (alarm) load is to be applied for 4 minutes. The battery terminal voltage of the discharged battery and the voltage of all output circuits is then to be measured.

49.2.5 If the system is marked for less than 24 hours of standby power, the test is then to be continued for a total discharge period of 24 hours.

49.3 Charged battery

49.3.1 The voltage of the charged battery as specified in 49.3.2 shall be at least 95 percent of the voltage measured in 49.2.2.

49.3.2 At the conclusion of the test sequence described in 49.2.2 – 49.2.5, AC input power is to be reapplied to the product for 48 hours. During the charging, the product is to be operated continuously with normal standby load connected. At the conclusion of the 48-hour recharge time, AC power is to be disconnected and the battery-terminal voltage measured after one minute.

49.4 Discharged battery – second trial

49.4.1 The measured voltage of all output circuits shall not be less than 85 percent of the marked ratings of the output circuits after the battery has been discharged as specified in 49.2.3 and 49.2.4 following the charging as specified in 49.3.2.

50 Abnormal Operation Test

50.1 A household burglar-alarm system unit energized in any condition of intended operation shall not increase the risk of fire or electric shock when abnormal fault conditions are introduced. There shall be no emission of flame or molten metal, or any other manifestation of a risk of fire, and the unit shall comply with the requirements of the Dielectric Voltage-Withstand Test, Section 46, when tested as described in 50.2 and 50.3.

50.2 The product is to be connected to a source of supply in accordance with 28.2.2 and operated under the most severe abnormal fault conditions likely to be encountered in service.

50.3 The fault condition is to be maintained continuously until constant temperatures are attained, or until burnout occurs, if the fault does not result in the operation of an overload protective device. Shorting of the secondary of the power supply transformer and shorting of an electrolytic capacitor are typical fault conditions.

50.4 If a product has provisions for connection to a telephone, telegraph, or outside wiring as covered by Article 800 of the National Electrical Code, ANSI/NFPA 70, the product shall comply with the overvoltage test described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

51 Electrical Transient Tests

51.1 General

51.1.1 A household burglar-alarm system unit, other than that operating from a primary battery, shall operate for its intended signaling performance after being subjected to 500 supply line transients, 500 internally induced transients, and 60 input/output circuit transients while energized from a source of supply in accordance with Table 28.1.

51.2 Supply line transients

51.2.1 A high-voltage AC-operated unit shall not false alarm, operate as intended, and, as appropriate, retain required stored memory (such as date, type, and location of a signal transmission) within the unit

when subjected to supply line transients induced directly between the power supply circuit conductors of the equipment under test and ground. Supplemental information stored within the unit need not be retained.

51.2.2 For this test, the unit is to be connected to a transient generator that produces the transients described in 51.2.3. The output impedance of the transient generator is to be 50 ohms.

51.2.3 The transients produced are to be oscillatory and are to have an initial peak voltage of 6000 volts. The rise time is to be less than 1/2 microsecond. Successive peaks of the transient are to decay to a value of no more than 60 percent of the value of the preceding peak.

51.2.4 The unit is to be subjected to 500 oscillatory transient pulses induced at a rate of six transients per minute. Each transient pulse is to be induced 90 degrees into the positive half of the 60 hertz cycle. A total of 250 pulses are to be applied so that the polarity of the transients is positive with reference to earth ground, and the remaining 250 pulses are to be negative with respect to earth ground.

51.3 Internally induced transients

51.3.1 The product is to be energized in the supervisory condition while connected to a source of supply in accordance with Table 28.1. The supply source is to be interrupted a total of 500 times. Each interruption is to be for approximately 1 second at a rate of not more than six interruptions per minute. At the conclusion of the test, the product shall operate for its intended signaling performance. Standby power shall be connected if it is provided.

51.4 Input/output circuit transients

51.4.1 Each input/output circuit is to be tested as specified in 51.4.2 – 51.4.5. The signaling equipment connected to these circuits shall not false alarm, operate as intended, and, as appropriate, retain required stored memory (such as date, type, and location of a signal transmission) within the unit when subjected to transient voltage pulses as described in 51.4.3. Supplemental information stored within the unit need not be retained.

Exception: A circuit or cable that interconnects equipment located within the same room need not be subjected to this test.

51.4.2 The unit is to be energized in the normal standby condition while connected to a source of supply in accordance with Table 28.1.

51.4.3 For this test, each input/output circuit is to be subjected to five different transient waveforms having peak voltage levels in the range of 100 to 2400 volts, as delivered into a 200 ohm load. A transient waveform at 2400 volts shall have a pulse rise time of 100 volts per microsecond, a pulse duration of approximately 80 microseconds, and an energy level of approximately 1.2 joules. Other applied transients shall have peak voltages representative of the entire range of 100 to 2400 volts, with pulse durations from 80 to 1110 microseconds, and energy levels not less than 0.03 joule or greater than 1.2 joules. The transient pulses are to be coupled directly onto the output circuit conductors of the equipment under test.

51.4.4 Each input/output circuit is to be subjected to 60 transient pulses introduced at the rate of six pulses per minute as follows:

a) Ten pulses (two at each transient voltage level specified in 51.4.3) between one side of each input/output circuit and earth ground. Repeat the ten pulses with the polarity reversed (total of 20 pulses).

b) Repeat (a) between the other side of each input/output circuit and earth ground (total of 20 pulses).

c) Ten pulses (two at each transient voltage level specified in 51.4.3) across each input/output circuit. Repeat the ten pulses with the polarity reversed (total of 20 pulses).

51.4.5 For these tests[a], the transient generator is to be connected to its alternating current (AC) power source through an isolating transformer. The earthground of the transient generator is to be disconnected from earthground.

a) For 51.4.4 (a) and (b), one output of the transient generator is connected to the earthground connection of the product under test, and the other output is connected through a decoupling fixture to the terminal to be tested. To reverse the polarity, the connection at the product under test is reversed. The earthground of the product shall be connected to earthground.

b) For 51.4.4(c), one output of the transient generator is connected to one of the terminals to be tested and the other output is connected through a decoupling fixture to the other terminal to be tested. To reverse the polarity, the connection at the product under test is reversed. If the product is equipped with an earthground, it shall be connected to earthground.

The decoupling fixture is a 200-ohm, 10-watt (minimum) resistor in series with a 1-microfarad, 1000-volt DC (minimum) capacitor.

[a] CAUTION: Potentially lethal voltage are involved. The transient generator and the product under test are to be on a non-conductive surface and appropriate safety precautions observed.

51.4.6 At the conclusion of the test, the equipment shall comply with the requirements of the Operation Test, Section 29.

52 AC Induction Test

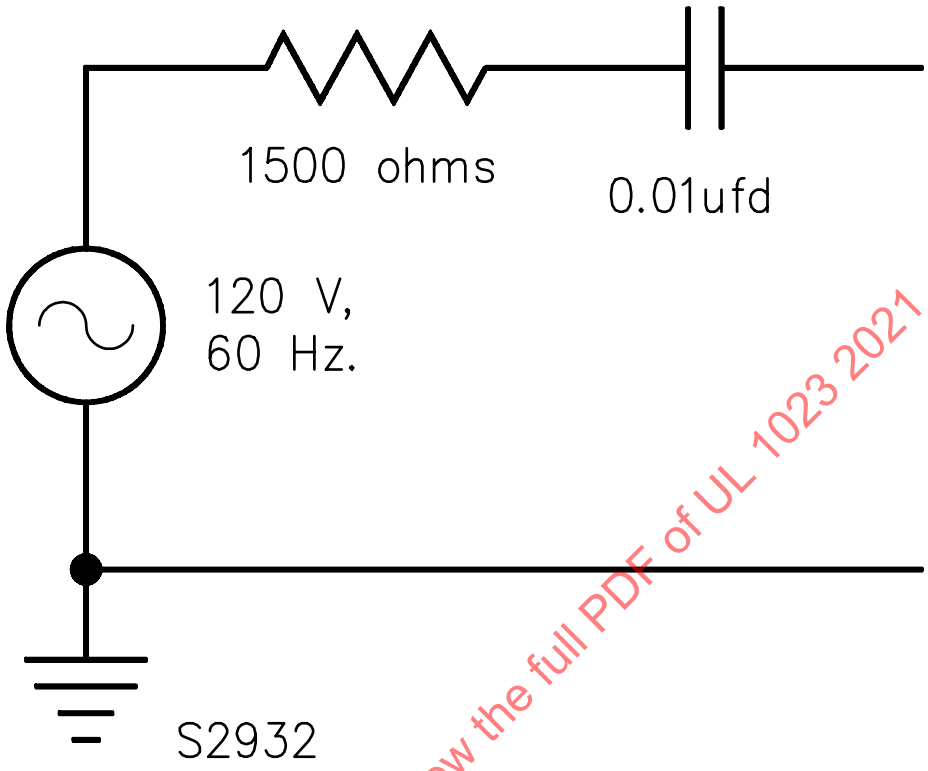
52.1 A household burglar-alarm system unit shall not false alarm and shall operate as intended when subjected to an alternating current induced on any signal lead, sensing lead, loop, DC power lead, or any other lead that extends throughout the premises wiring.

Exception: A lead consisting of a conductor insulated from and surrounded by a shielding, conductive surface grounded at one end need not be subjected to this test.

52.2 The product is to be energized from a source of rated voltage and frequency in accordance with 28.2.2, and a 60-hertz alternating current is to be injected into each circuit extending from the product (see 52.1). The AC signal current shall be induced as illustrated in Figure 52.1 to simulate induction from an AC power source.

Figure 52.1

AC induction test circuit



53 Tests on Polymeric Materials

53.1 Polymeric materials used as an enclosure or for the support of current-carrying parts shall comply with the applicable portion of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

54 Audibility Test

54.1 An alarm sounding device, either integral with the household burglar-alarm system unit or intended to be connected separately, shall provide a sound output equivalent to that of an omnidirectional source with an A-weighted sound pressure level of at least 85 decibels at 10 feet (3.05 m) while connected to a source of rated voltage in accordance with 28.2.2.

54.2 The sound power output of the alarm sounding device shall be measured in a reverberant room qualified for pure tones under Precision Methods for the Determination of Sound Power Levels of Broad-Band Noise Sources in Reverberation Rooms, ANSI S12.31-1990, or Precision Methods for the Determination of Sound Power Levels of Discrete-Frequency and Narrow-Band Noise Sources in Reverberation Rooms, ANSI S12.32-1990. The sound power in each one-third octave band shall be determined using the comparison method. The A-weighting factor shall be added to each one-third octave band. The total power shall then be determined on the basis of actual power. The total power shall then be converted to an equivalent sound pressure level for a radius of 10 feet (3.05 m) using the following formula:

$$L_p = L_W - 20Log_{10}R - 0.6$$

in which:

L_p is the converted sound pressure level,

L_w is the sound power level measured in the reverberation room, and

R is the radius for the converted sound pressure level (10 feet).

Exception: This requirement does not apply to trouble signals.

55 Battery Replacement Test

55.1 The battery clips of a battery operated household burglar-alarm system unit shall withstand 50 cycles of removal and replacement from the battery terminals without any reduction in contact integrity. The test shall not impair the intended operation of the product.

55.2 For this test, a product is to be installed as intended in service and the battery/batteries removed and replaced as recommended by the manufacturer. The product then shall be tested for intended operation. See the Operation Test, Section 29.

56 Drop Test

56.1 As the result of being dropped as specified in 56.2, the electrical spacings within a cord-connected high-voltage product shall not be reduced below the limits specified in 27.1 – 27.6. No high-voltage electrically live metal parts shall be exposed as a result of this test.

56.2 A sample of a cord-connected high-voltage product is to be dropped four times from a height of 3 feet (0.9 m) onto a hardwood floor. If it has corners, it is to be dropped on a different corner each time, selecting the corners that appear to be most susceptible to damage. If the product has no corners, it is to be dropped on the four portions that appear to be most susceptible to damage. If the product is intended to use internally mounted batteries, the batteries shall be in place for this test.

56.3 Following the test described in 56.2, the product is to be wrapped in bleached cheesecloth running 14 – 15 square yards to the pound (26 – 28 m^2/kg) and having what is known in the trade as a count of 32 by 28, that is, in any inch square there are 32 threads in one direction and 28 threads in the other direction (in any cm square, 13 threads in one direction, 11 in the other). The product is to be energized for 3 hours at rated voltage in accordance with 28.2.2. There shall be no molten metal or flame emitted from the unit, as evidenced by ignition or charring of the cheesecloth. The product shall also comply with the requirements of the Dielectric Voltage-Withstand Test, Section 46, following this test.

57 Strain Relief Test

57.1 General

57.1.1 When tested in accordance with 57.1.2, the strain relief means provided on the flexible cord shall withstand, without displacement, the force applied to the cord. There shall be no movement of the cord to indicate that stress would have been transmitted to the connections.

57.1.2 During this test, the connections within the product are to be disconnected. A 35-pound (15.88-kg) weight is to be suspended on the cord and supported by the product so that the strain relief means will be stressed for 1 minute from any angle that the construction of the product permits.

57.2 Field-wiring leads

57.2.1 Each lead employed for field connections shall withstand a pull of 10 pounds (44.5 N) for 1 minute without any evidence of damage or of transmittal of stress to the internal connections.

58 Ignition Through Bottom-Panel Openings Tests

58.1 General

58.1.1 Both of the bottom-panel constructions described in 10.2.4 are not required to be tested. Other constructions are capable of being used when they pass the test described in 58.2.1 – 58.2.4.

Exception: This test does not apply to low-voltage, power-limited products or to products in which an internal fault does not produce flame, molten metal, flaming or glowing particles, or flaming drops.

58.2 Hot flaming oil

58.2.1 Openings in a bottom panel shall be so arranged and sufficiently small in size and few in number that hot, flaming No. 2 furnace oil poured three times onto the openings from a position above the panel is extinguished as it passes through the openings.

58.2.2 A sample of the complete, finished bottom panel is to be securely supported in a horizontal position several inches above a horizontal surface under a hood or in another area that is well ventilated but free from significant drafts. One layer of bleached cheesecloth of the type described in 56.3 is to be draped over a shallow, flat-bottomed pan that is of sufficient size and shape to completely cover the pattern of openings in the panel but is not to be large enough to catch any of the oil that runs over the edge of the panel or otherwise does not pass through the openings. The pan is to be centered under the pattern or openings in the panel. The center of the cheesecloth is to be 2 inches (50.8 mm) below the openings. Use of a metal screen or wired-glass enclosure surrounding the test area is recommended to reduce the risk of injury to persons and damage due to splattering of the oil.

58.2.3 A small metal ladle [preferably no more than 2-1/2 inches (63.5 mm) in diameter] with a pouring lip and a long handle whose longitudinal axis remains horizontal during pouring is to be partially filled with 10 milliliters of No. 2 furnace oil, which is a medium-volatile distillate having an API gravity of 32 – 36 degrees, a flash point of 110 – 190°F (43 – 88°C), and an average calorific value of 136,900 Btu per gallon (39.7 MJ/liter). See Specification for Fuel Oil, ASTM D396-86). The ladle containing the oil is to be heated and the oil ignited. After burning for 1 minute, all of the hot, flaming oil is to be poured from a position 4 inches (102 mm) above the opening and at a rate of approximately, but not less than, 1 milliliter per second in a steady stream onto the center of the pattern of openings.

58.2.4 Five minutes after completion of the pouring of the oil, the cheesecloth is to be replaced with a clean piece and a second 10-milliliters of hot, flaming oil is to be poured from the ladle onto the openings. Five minutes later, a third identical pouring is to be made. The openings are not acceptable if the cheesecloth is ignited during any of the three pourings.

59 Mechanical Strength Tests for Enclosures

59.1 The external enclosure of a product using high-voltage or high energy circuits shall withstand without permanent distortion to the extent that spacings are reduced below the values specified in 27.1 – 27.6, or without transient distortion that results in contact with live parts and without causing openings that would expose uninsulated high- or low-voltage live parts that involve a risk of electric shock:

a) A force of 25 pounds (111 N) for 1 minute and

b) An impact of 5 foot-pounds (6.78 J).

Any openings that occur during application of the force or impact are to be judged according to the requirements specified in 10.2.2 and 10.2.3.

59.2 The force specified in 59.1 (a) is to be applied by means of a 1/2 inch (12.7 mm) diameter hemisphere.

59.3 The impact specified in 59.1(b) is to be applied by means of a solid, smooth, steel sphere 2 inches (50.8 mm) in diameter and weighing approximately 1.18 pounds (0.54 kg) falling freely from rest through a vertical distance of 51 inches (1.3 m).

59.4 For products using low voltage and limited energy, the tests specified in 59.1 are to be performed with a force of 10 pounds (44 N) and an impact of 2 foot-pounds (2.7 J).

60 Special Terminal Assemblies Tests

60.1 General

60.1.1 To determine compliance with the requirements for field wiring connection specified for Special Terminal Assemblies, Section 16, representative samples of the terminal assembly shall comply with the requirements specified in 60.2.1 – 60.6.2.

Exception: Terminals complying with the requirements in any of the standards specified in 15.2 are not required to be subjected to these tests.

60.2 Disconnection and reconnection

60.2.1 If a wire is intended to be disconnected for testing or routine servicing and then reconnected, each terminal shall be subjected to 20 disconnections and 20 reconnections prior to the tests described in 60.3.1 – 60.6.2.

60.3 Mechanical secureness

60.3.1 A terminal connection shall withstand, without separation from the wire, the application of a straight pull of 5 pounds-force (22.2 N), applied for 1 minute to the wire in the direction that would most likely result in pullout.

60.3.2 Six terminal assemblies using the maximum wire size and six assemblies using the minimum wire size are to be subjected to this test. If a special tool is required to assemble the connection it is to be used, in accordance with the manufacturer's instructions. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 5 pounds-force (22.2 N) is reached.

60.4 Flexible test

60.4.1 The wire attached to a terminal shall withstand five right angle bends without breaking.

60.4.2 Six terminal assemblies employing the maximum wire size and six with the minimum wire size are to be subjected to this test. The terminal is to be rigidly secured to prevent any movement. With each wire 3 pounds-force (13.3 N) tension and held at a point 3 inches (76.2 mm) from the terminal-to-wire juncture, each wire is to be bent at a right angle from its nominal position. The wires are to be assembled to the terminals using any special tool required, according to the manufacturer's instructions. The tension on the wire shall hold the wire in a rigid position during the flexing trials.

60.5 Millivolt drop test

60.5.1 The millivolt drop across a terminal connection using the maximum and minimum wire sizes intended to be employed, and with the terminals connected in series, shall be not greater than 300

millivolts with the manufacturer's maximum specified current flowing through the terminal connection and the circuit connected to the rated voltage.

60.5.2 Six terminal assemblies employing the maximum wire sizes and six assemblies employing the minimum wire sizes are to be subjected to this test. The wires are to be assembled to the terminals, using any special tool, if required, according to the manufacturer's instructions. The millivolt drop then is to be measured by using a high impedance millivoltmeter with the maximum current, as specified by the manufacturer, flowing through the connection.

60.6 Temperature test

60.6.1 The maximum temperature rise on a terminal junction using the maximum and minimum wire sizes with which the terminal is intended to be employed shall be not greater than 30°C (54°F) based on an ambient temperature of 25°C (77°F).

60.6.2 Six terminal assemblies employing the maximum wire size and six employing the minimum wire size are to be subjected to this test. The wire is to be assembled to the terminals using any special tools, if required, according to the manufacturer's instructions. The maximum current to which the wire will be subjected in service then is to be passed through the terminal connection. The maximum temperature rise then is to be measured by the thermocouple method in accordance with the Temperature Test, Section 48, after temperatures have stabilized.

SHORT-RANGE RADIO FREQUENCY DEVICES

61 General

61.1 These requirements are applicable to control units and systems that utilize initiating, annunciating, and remote control devices that are not interconnected by a solid medium, such as cable, optical fiber, or the like.

61.2 The requirements specified in Sections 1 – 60 shall apply to short range radio frequency (RF) devices except that in the event of conflict, the requirements in Sections 61 – 83 shall apply.

61.3 These requirements are applicable to a system configuration consisting of multiple transmitters and a single receiver with the transmitters operating on a random basis, and with modifications, to a system employing such configurations as multiple receivers or a two-way interrogated response system.

62 Reference Level Determination

62.1 Method 1

62.1.1 The reference level test is not intended to determine the actual service communication range of a transmitter/receiver combination. Rather, this data is utilized as a reference level for the testing specified in Sections 63 – 73. The range determined during the ideal conditions of this test should not be considered representative of the actual range within a building structure, which will probably be significantly less. A transmitter/receiver combination shall operate for its intended signaling performance when tested in a configuration at minimum signal strength, measured at the receiver, as specified by the manufacturer's installation instructions.

62.1.2 The tests are to be conducted in an open, flat area characteristic of cleared, level terrain. Such test sites are to be:

a) Void of buildings, electrical lines, fences, trees, or the like,

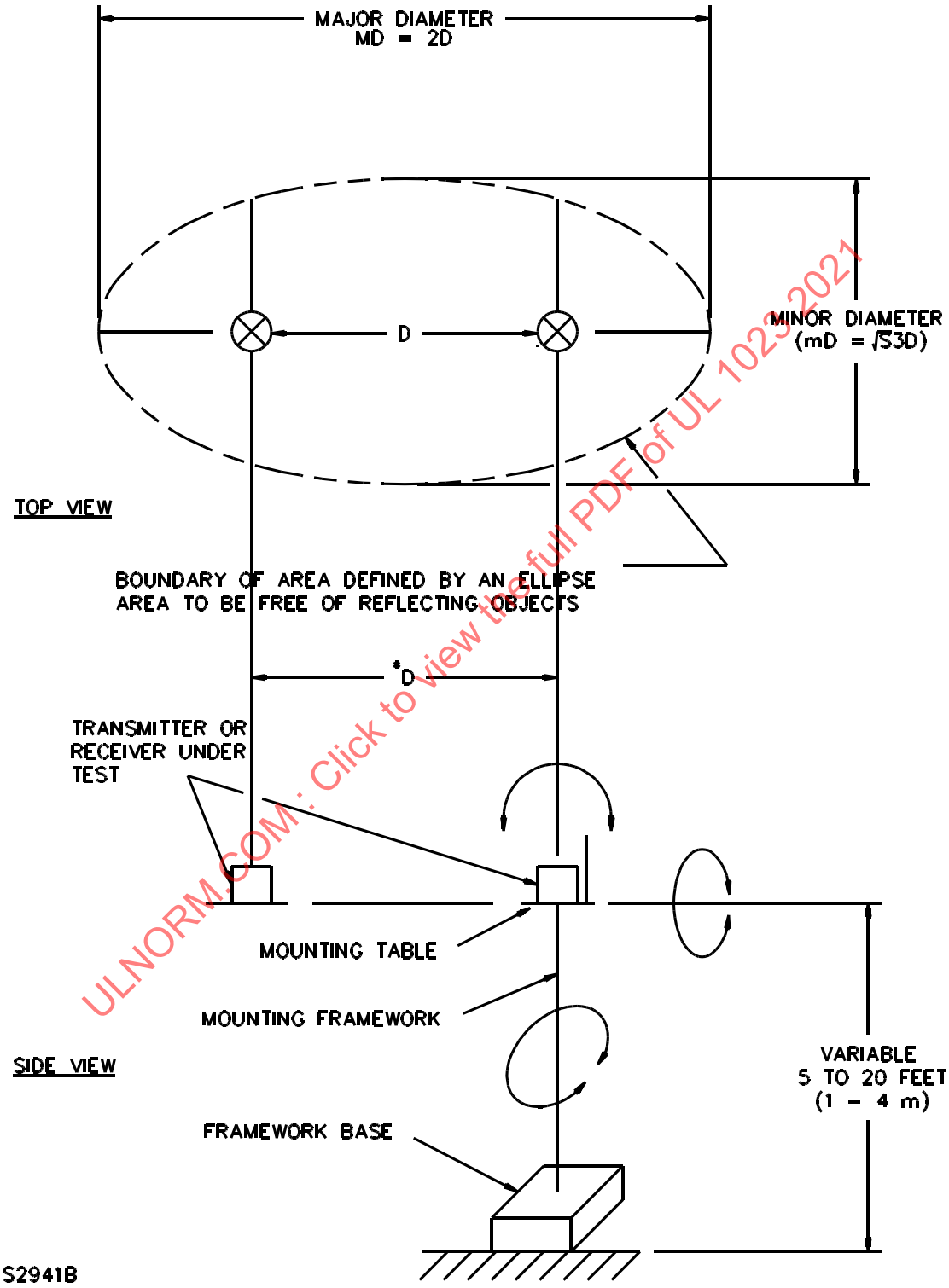
b) Free from underground cables, pipes, lines, or the like, except as required to supply and operate the equipment under test, and

c) Free of snow and water accumulations.

The ambient radio noise level and other undesired signals are to be sufficiently low (see Methods Of Measurement Of Radio-Noise Emissions From Low-Voltage Electrical And Electronic Equipment In The Range Of 10 kHz To 1 GHz, ANSI C63.4-1981)so as not to interfere with the measurements. Any large reflecting object, such as a metal fence or the like, is to be sufficiently far from the test site so as not to influence the test results. See Figure 62.1.

Figure 62.1

Test site and equipment arrangement



D = For Method 1, manufacturer's maximum specified range, not less than 10 feet (3.05 m). Test site to comply with 62.1.1 within area defined by boundary in top view. If Method 2 is used, D = 3 meters (9.84 ft).

NOTE: Signal strength is measured at receiver.

62.1.3 The equipment under test is to be positioned as intended in use on a wooden or other nonconducting table and framework that will permit the transmitter and receiver to be relatively oriented for worst-case communication. The mounting of the table on the framework is to be arranged so that the table surface can be adjusted to elevations of 5, 10, and 20 feet (1.5, 3, and 6 m). The number of elevations and relative positions may be reduced if the manufacturer's installation instructions provide specific limitations relating to orientation, as well as a method of testing as specified in 62.1.4.

62.1.4 Worst-case communication is that relative orientation between transmitter and receiver that results in the minimum field strength specified by the manufacturer, measured at the receiver by the appropriate installation aids and test equipment designated for that purpose.

62.1.5 The equipment and procedures specified in the installation instructions are to be used to establish test installation of the RF system.

62.1.6 A sample transmitter with fresh batteries and a sample receiver are to be placed on similar tables, as specified in 62.1.3, resulting in a separation at the maximum range specified for the transmitter/receiver combination.

62.1.7 A transmitter is to be remotely activated by a nonconductive mechanism that will not increase the effective radiating or receiving size of the antenna.

62.1.8 The transmitter or receiver is to be rotated through a 90-degree angle in each of the three orthogonal axes with either the transmitter or receiver fixed in position, and the level of the received signal is to be observed for worst-case communication. The test is to be conducted at the 5, 10, and 20 foot (1.5, 3, and 6 m) elevations or as otherwise specified in 62.1.3.

62.1.9 The test is to be repeated with batteries depleted to the trouble level as specified in 71.1 – 71.4. For the purpose of this requirement, a depleted battery is defined as a battery that is at the level (terminal voltage under load) that results in a trouble signal as required in 71.1 – 71.4. For test purposes, a depleted battery may be substituted by a circuit arrangement that does not affect the RF characteristic (±6 decibels as measured at the receiver), but does simulate the characteristics of a depleted battery as specified in 71.2.

62.2 Method 2

62.2.1 This test may be alternately conducted in a 3-meter (9.84-ft) site as described in Recommended Methods of Measurement of Radiated and Conducted Interference From Receivers for Amplitude-Modulation, Frequency Modulation, and Television Broadcast Transmissions, IEC Standard Publication 106-1974 or Methods Of Measurement Of Radio-Noise Emissions From Low-Voltage Electrical And Electronic Equipment In The Range Of 1 kHz To 1 GHz, ANSI C63.4-1981. If Method 2 is used, the test methodology described in 62.1.1 – 62.1.8 is to be followed except that the attenuation factors for receiver/transmitter specified in Figure 62.2 are to be utilized as scaling factors. 62.2.2 – 62.2.5 specify details in applying Method 2.