UL 1610

STANDARD FOR SAFETY

Central-Station Burglar-Alarm Units

ULNORM.COM : Click to view the full PDF of UL 1610 2021

ULNORM.COM : Click to view the full PDF of UL 1610 2021

UL Standard for Safety for Central-Station Burglar-Alarm Units, UL 1610

Fourth Edition, Dated July 5, 2016

Summary of Topics

This revision of UL 1610 dated April 21, 2021 is issued to remove the ANSI designation from the standard.

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.

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

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

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

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

ULNORM.COM : Click to view the full PDF of UL 1610 2021

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 1610 2021

JULY 5, 2016
(Title Page Reprinted: April 21, 2021)

1

UL 1610

Standard for Central-Station Burglar-Alarm Units

First Edition – January, 1985
Second Edition – May, 1994
Third Edition – October, 1998

Fourth Edition

July 5, 2016

This UL Standard for Safety consists of the Fourth Edition including revisions through April 21, 2021.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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

COPYRIGHT © 2021 UNDERWRITERS LABORATORIES INC.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 1610 2021

CONTENTS

INTRODUCTION

CONSTRUCTION

ASSEMBLY

FIELD IRING CONNECTIONS

INTERNAL WIRING

COMPONENTS, ELECTRICAL

ULNORM.COM : Click to view the full PDF of UL 1610 2021

SPACINGS

PERFORMANCE – ALL UNITS

ULNORM.COM : Click to view the full PDF of UL 1610 2021

ULNORM.COM : Click to view the full PDF of UL 1610 2021

ULNORM.COM : Click to view the full PDF of UL 1610 2021

MARKING

ACCESSORY EQUIPMENT

APPENDIX A

APPENDIX B

ULNORM.COM : Click to view the full PDF of UL 1610 2021

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 1610 2021

INTRODUCTION

1 Scope

1.1 These requirements cover components of central-station burglar-alarm systems intended and specifically designated for burglary-protection use at mercantile and banking premises, on mercantile safes, and on bank safes and vaults.

1.2 The components covered by these requirements are intended for use in a burglar-alarm system in which the operations of electrical protection circuits and devices are transmitted automatically to, recorded in, maintained from, and supervised from a central-station that employs trained operators and alarm investigators who are in attendance at all times.

1.3 These requirements serve as the basis of classification of central-station burglar-alarm system transmission methods. The systems may be classified as either standard line security equipment or encrypted line security equipment by virtue of the construction and performance requirements for components of that system. However, requirements covering the complete systems are contained in the Standard for Central-Station Alarm Services, UL 827.

1.4 Protective devices installed on individual properties are further classified as to extent of protection at each location, according to the requirements covering installation and classification (of extent) of alarm protective equipment at individual locations as published in the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681.

1.5 If equipment covered by these requirements is intended for use in a combination burglar-alarm and fire-protective signaling system, the portion of the equipment serving a fire-alarm function is covered by the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

1.6 Systems covered by these requirements operate using Class 2 remote-control and signaling circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

1.7 The requirements assume that standard telephone operating practices are acceptable for leased or other lines connecting to a central-station as defined by Article 800 of the National Electrical Code, NFPA 70.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

2.1.2 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.

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

ULNORM.COM : Click to view the full PDF of UL 1610 2021

2.1.4 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.

2.2 Units of measurement

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

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

2.3 Undated references

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

2.4 Terminology

2.4.1 The term "product" as used in this standard refers to all types of central-station burglar-alarm units.

3 Glossary

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

3.2 ACKNOWLEDGMENT SIGNAL – An audible and/or visual signal that is sent to the subscriber by the central station to notify the subscriber that a signal has been received indicating that the protection system has been properly armed. The acknowledgment signal can be sent manually or automatically.

3.3 ADMINISTRATOR – An authorized entity that is in possession of the credentials necessary for the ability to perform an upgrade to a control unit's software and/or firmware.

3.4 BIOMETRICS – Authentication of human physical characteristics used to identify an individual.

3.5 CIRCUITS, ELECTRICAL:

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

b) Low-Voltage – A circuit involving a potential of not more than 30 volts rms, 42.4 volts DC or AC peak.

c) Power-Limited – A circuit whose output is limited as specified in Table 3.1 and Table 3.2. The power limitation shall be provided by the construction of the transformer, a fixed impedance, a noninterchangeable fuse, a nonadjustable manual reset circuit protective device, or a regulating network.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

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

Circuit voltage V_{max}[a] AC-DC, volts	Maximum nameplate ratings		Current limitation I_{max},[b] amperes
	VA, volt-amperes	Current, amperes	
0 to 20	5.0 x V_{max}[a]	5.0	8.0
over 20 to 30	100	100/V_{max}[a]	8.0
over 30 to 100	100	100/V_{max}[a]	150/V_{max}[a]
over 100 to 250 DC[a] only	0.030 x V_{max}[a]	0.030	0.030

NOTE – Reprinted with permission from NFPA 70-1993, the National Electrical Code®, Copyright© 1992, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject is represented only by the standard in its entirety.

[a] V_{max}: Maximum output voltage regardless of load with rated input applied. 0 – 20 V-rms, 0 – 28.3 DC or AC peak; 20 – 30 V rms, 28.3 – 42.4 DC or AC peak.

[b] I_{max}: Maximum output current after 1 minute of operation under any noncapacitive load, including short circuit.

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

Circuit voltage V_{max}[a] AC-DC, volts	Maximum nameplate ratings		Current limitation I_{max},[b] amperes	Power limitation $(VA)_{max}$,[c] volt-amperes	Maximum overcurrent protection, amperes
	VA, volt-amperes	Current, amperes			
0 to 20	5.0 x V_{max}[a]	5.0	1000/V_{max}[a]	250[d]	5.0
over 20 to 100	100	100/V_{max}[a]	1000/V_{max}[a]	250[d]	100/V_{max}[a]
over 100 to 150	100	100/V_{max}[a]	1.0	NA	1.0

NOTE – Reprinted with permission from NFPA 70-1993, the National Electrical Code®, Copyright© 1992, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject is represented only by the standard in its entirety.

[a] V_{max}: Maximum output voltage regardless of load with rated input applied. See footnote a to Table 3.1.

[b] I_{max}: Maximum output current after 1 minute of operation under any noncapacitive load, including short circuit, and with overcurrent protection bypassed.

[c] $(VA)_{max}$: Maximum volt-ampere output regardless of load with overcurrent protection bypassed.

[d] If the power source is a transformer $(VA)_{max}$ is 350 or less than V_{max} is 15 or less.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

3.6 CORD-CONNECTED UNIT – A unit intended for connection to the power source by means of a supply cord. Such a unit is intended to be moved for reasons of interchange or realignment of the units of a system.

3.7 CREDENTIAL – A mechanism that defines or distinguishes the identity of an entity (e.g. a password, or PIN or biometric).

3.8 CRYPTOGRAPHIC AUTHENTICATION – Algorithms intended to ensure the secrecy and/or authenticity of messages.

3.9 DIGITAL ALARM COMMUNICATOR (DAC) – A transmission method as outlined in the Standard for Digital Alarm Communicator System Units,UL 1635, by cellular and/or telephone landline transmission.

3.10 ENTITY – Person, device, and/or appliance or service which interacts with a control unit.

3.11 EVENT LOG – A comprehensive data record, maintained at the control unit and/or central station of the events that are associated with remote access.

3.12 FIXED EQUIPMENT – A device intended to be permanently connected electrically.

3.13 HARDWIRE KEY DEVICE – A mechanical or electronic device employed to enable the remote programming mode.

3.14 LINE-VOLTAGE – The voltage at any field connected source of supply, nominally 50 – 60 Hertz (Hz); and either 115, 208, or 230 volts.

3.15 MANAGED FACILITIES-BASED VOICE NETWORK (MFVN) – A physical facilities-based network capable of transmitting real time signals with formats unchanged that is managed, operated, and maintained by the service provider to ensure service quality and reliability from the subscriber location to public switched telephone network (PSTN) interconnection points or other MFVN peer networks.

Reproduced with permission from NFPA 72®-2016, National Fire Alarm Code®, Copyright © 2015, National Fire Protection Association.

3.16 MULTIPLEXING – A signaling method using wire path, cable carrier, radio, or combinations of these methods characterized by the simultaneous and/or sequential transmission and reception of multiple signals in a communication channel including means for positively identifying each such signal.

3.17 NORMAL STANDBY CONDITION – The ready-to-operate condition of the product existing prior to its being tripped or operated by an intrusion.

3.18 PACKET SWITCHED DATA NETWORK (PSDN) – A type of data transmission in which data is divided into packets, each of which has a destination address. Each packet is then routed across a computer network. A packet may travel a different route than packets related to it.

3.19 PLAINTEXT – A character representation that is plainly readable as text and not masked and/or hidden.

3.20 PORTABLE EQUIPMENT – Cord- and plug-connected equipment that is capable of being carried or moved about.

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

3.22 RADIO FREQUENCY – Electromagnetic radiation, nominally above 20 kilohertz.

3.23 REMOTE ACCESS – The act of accessing a control unit at a distance from the protected premises, whereby the user does not have visual contact of the premises. Key FOB's are not included in this definition; because they are intended to be used when in visual contact with the protected premises and are very limited in the distance they may be used.

3.24 REMOTE COMMUNICATION – Data exchange in which information is exchanged between the control unit and an authorized entity.

3.25 REMOTE OPERATION – The connection to the protected premises control unit via remote communications.

3.26 SAFETY CIRCUIT – Any primary or secondary circuit that is relied upon to reduce the risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons (for example, an interlock circuit).

ULNORM.COM : Click to view the full PDF of UL 1610 2021

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

3.28 SIGNAL TRANSMISSION METHODS – Any of the following methods; direct wire, multiplex, derived channel, two way radio (RF), DACT/DACR, one way radio (RF), packet switched data network, or code transmitter.

3.29 STATIONARY EQUIPMENT – Cord- and plug-connected equipment that is intended to be fastened in place, or located in a dedicated space.

3.30 TRUSTED PHYSICAL PATH – A contiguous and visible path for communications constructed of physical media. A directly connected crossover network cable, USB cable, or vendor approved cable would be considered a trusted path.

3.31 USER – A person who has authorized access to the control unit.

3.32 USER VALIDATION – The act of an electronic device, upon the input of "user credentials", validating that the credentials are legitimate, allowing the user to proceed to access the system, or upon failure to match the credentials, deny access to the system. (See Appendix B).

4 Installation and Operating Instructions

4.1 A copy of the:

a) Installation and operating instructions intended to accompany each product or component as produced,

b) Related schematic wiring diagrams, and

c) Installation drawings

shall be furnished with the sample submitted for investigation, to be used as a guide in the examination and test of the product or component. For this purpose, a final printed edition is not required.

4.2 The instructions and drawings shall include at least the following:

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, the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681, and the Standard for Central-Station Alarm Services, UL 827. Locations where installations are not recommended shall also be included.

b) Concise description of the operation, testing, and maintenance procedures for the product(s), and recommended testing frequency that shall be at least once per year.

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 any features provided to reduce the risk of fire, electric shock, or injury to persons and a warning against bypassing such features.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

4.3 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 Marking, General, Section 100.

5 Installation and Operating Instructions Physical Media

5.1 The installation diagram(s) and any special field installation instructions shall be attached to the unit or, when separate, shall be provided in printed hardcopy format. A copy shall be supplied with each individual product or with each single shipment when multiples of the same products are shipped directly (to an end customer) in a single shipment.

5.2 The following sections contain information that shall be provided in printed hardcopy format and supplied with the unit(s):

a) 4.2(a);

b) 13.2.3.1(b);

c) 13.2.3.2(a);

d) 13.2.3.2(b);

e) 13.2.3.2(c);

f) 13.3;

g) Section 34, Variable Ambient Test;

h) 100.1, Exception No. 1;

i) 100.3;

j) 100.4;

k) 100.11;

l) 103.3;

m) 103.4; and

n) 105.3.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

5.3 Other installation instructions, operating and test instructions shall be made available by printed hardcopy or by electronic media such as a CD, DVD, website, or equivalent. Optionally, a copy may be supplied with each individual product or with each single shipment when multiples of the same products are shipped directly (to an end customer) in a single shipment.

6 Electric Shock

6.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See Electric Shock Current Test, Section 37.

6.2 The insertion of the intended component into a socket of a device in the product shall not result in a risk of electric shock.

CONSTRUCTION

ASSEMBLY

7 General

7.1 Product assembly

7.1.1 The product shall be factory-built as a complete assembly and shall include all the components necessary for its intended function when installed and used as intended. The product may be shipped from the factory as two or more major subassemblies. See 7.1.2.

7.1.2 If the product is not assembled by the manufacturer as a complete unit, it shall be arranged in major subassemblies. Each subassembly shall be capable of being incorporated into a complete assembly without requiring alteration, cutting, drilling, threading, welding, or similar tasks by the installer. Two or more subassemblies that must bear a definite relationship to each other for the correct installation or operation of the product shall be arranged and constructed to permit them to be incorporated into the complete assembly only in the correct relationship without need for alteration or alignment, or such subassemblies shall be assembled, tested, and shipped from the factory as one unit.

7.2 Electrical protection

7.2.1 Louvers and other openings in the enclosure shall be constructed and located to reduce the risk of unintentional contact with uninsulated high-voltage live parts. In determining compliance with this requirement, parts such as covers, panels, and grilles used as part of the enclosure are to be removed unless tools are required for their removal or an interlock is provided. See also Protection of Service Personnel, Section 8.

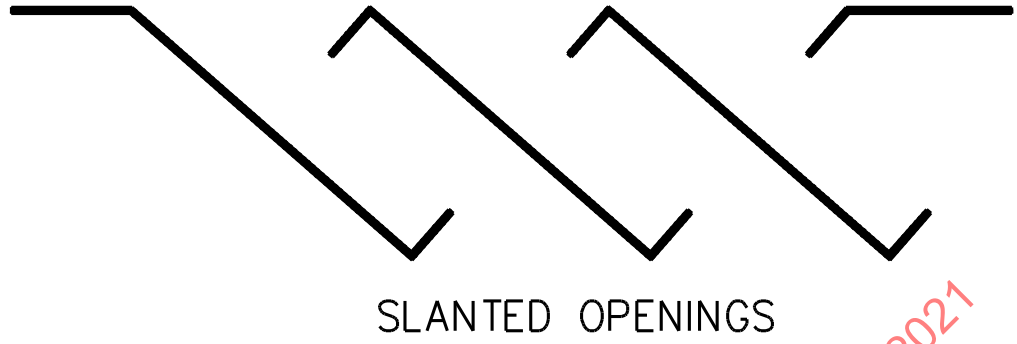
7.2.2 Uninsulated high-voltage live parts shall be located, guarded, or enclosed as indicated in 7.2.3 – 7.2.5.

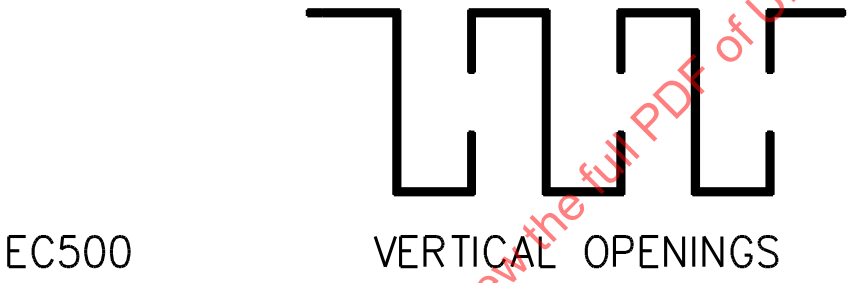
7.2.3 Openings directly over uninsulated high-voltage live parts shall not exceed 0.187 inch (4.75 mm) in any dimension, or shall be of a configuration as illustrated by Figure 7.1 for top cover designs and Figure 7.2 for side opening designs, or the equivalent.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 7.1

Cross sections of top cover designs

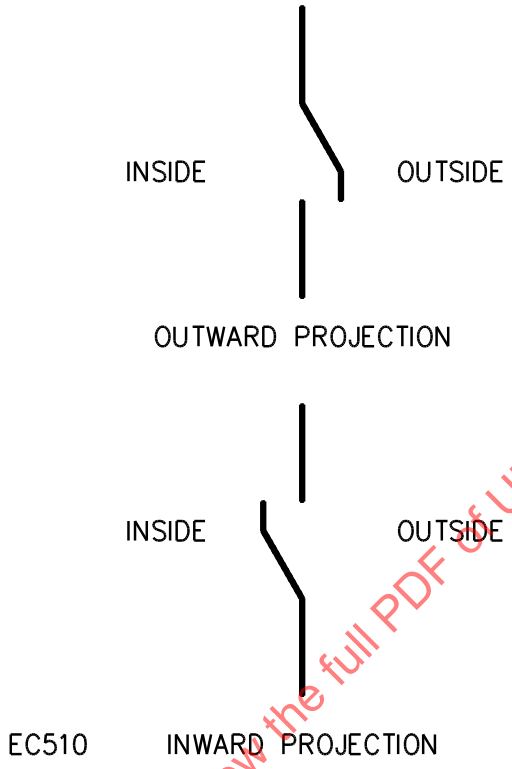




ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 7.2

Cross sections of side louvers



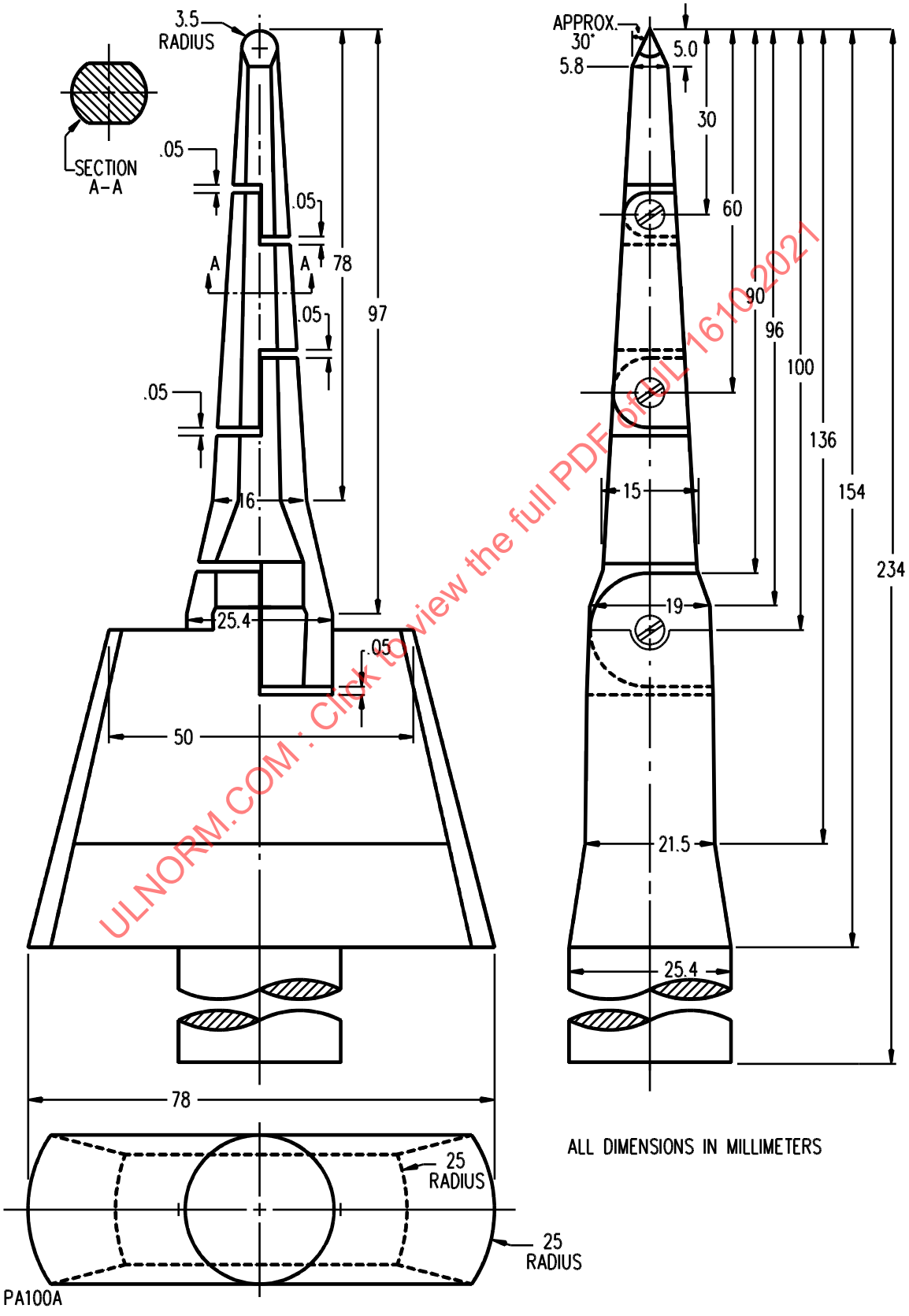
ULNORM.COM : Click to view the full PDF of UL 1610 2021

7.2.4 An opening in an electrical enclosure that does not permit entrance of a 1 inch (25.4 mm) diameter rod shall be sized and arranged so that a probe, as illustrated in Figure 7.3, cannot be made to contact any uninsulated live part (other than low voltage) when inserted through the opening in a straight or articulated position.

7.2.5 An opening that permits entrance of a 1 inch (25.4 mm) diameter rod may be used under the conditions described and illustrated in Figure 7.4.

Figure 7.3

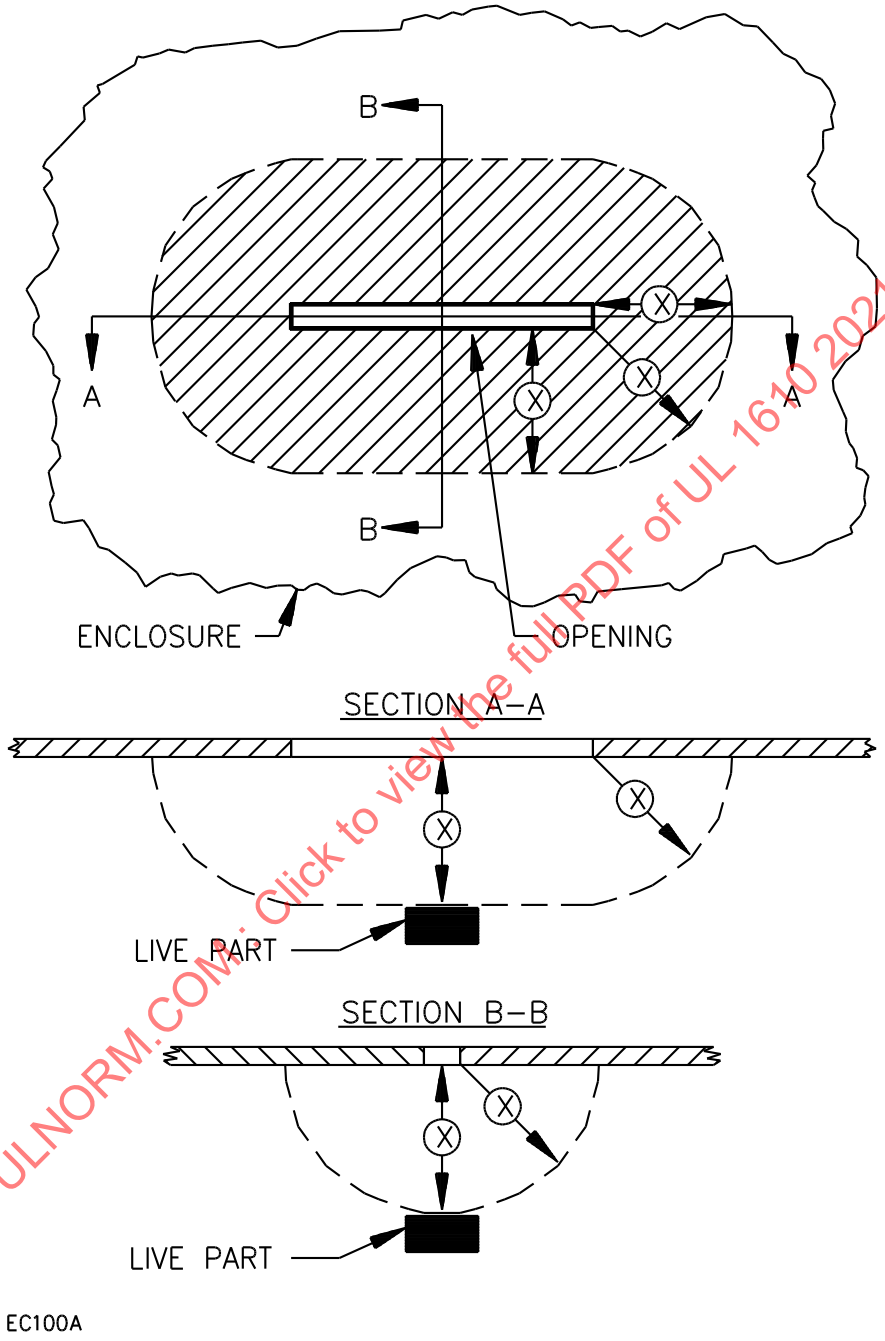
Accessibility probe



ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 7.4

Opening in enclosure



EC100A

NOTE – The opening may be used 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 that can be inserted through the opening, but not less than 6-1/16 inches (154 mm).

ULNORM.COM : Click to view the full PDF of UL 1610 2021

7.2.6 Knockouts or openings in an alarm sounding device housing for the connection of circuits shall be in the mounting surface only.

8 Protection of Service Personnel

8.1 An uninsulated live part of a high-voltage circuit within the enclosure shall be located, guarded, or enclosed so as to reduce the risk of unintentional contact by persons performing service functions that may be performed while the equipment is energized.

8.2 During the examination of a product in connection with the requirements in 8.1, a part of the outer enclosure that may be removed without the use of tools, or a part of the outer enclosure that may be removed by the user to allow access for making routine operating adjustments, shall be disregarded; it shall be assumed that the removable part in question does not afford protection against the risk of electric shock.

8.3 An electrical component that may require examination, replacement, adjustment, servicing, or maintenance while the product is energized shall be located and mounted with respect to other components and with respect to grounded metal so that the component is accessible for such service, and risk of electric shock to the service person from adjacent uninsulated high-voltage live parts is reduced.

9 Enclosures

9.1 General

9.1.1 The enclosure of a product shall have the strength and rigidity to resist total or partial collapse and the attendant reduction of spacings, loosening or displacement of parts, or other defects. See Mechanical Strength Tests for Enclosures, Section 51.

9.1.2 Operating parts, such as gear mechanisms, light-duty relays, and similar devices, shall be enclosed to protect against malfunction due to dust or other material that may impair their intended operation.

9.1.3 An enclosure containing other than power-limited circuits shall be constructed to reduce the possibility of emission of flame, molten metal, flaming or glowing particles, or flaming drops. See Ignition Through Bottom-Panel Openings Tests, Section 50.

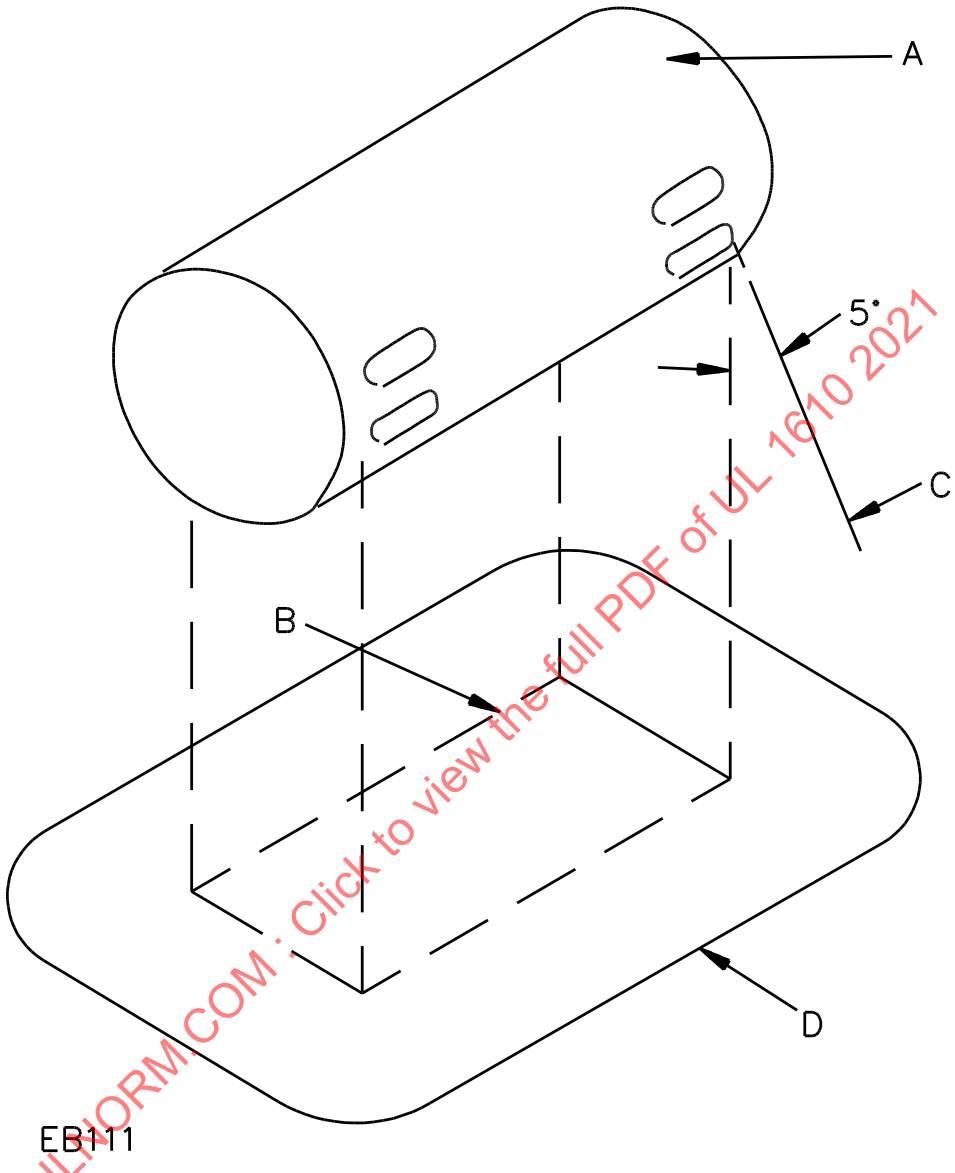
9.1.4 The requirement in 9.1.3 necessitates either a nonflammable bottom in accordance with the requirements in 9.3.2, or a protective barrier as illustrated in Figure 9.1 under all areas containing combustible materials.

Exception: Openings not larger than 1/16 square inch (40.3 mm^2) may be provided for the bottom of the enclosure under areas containing only materials classified as V-1 or less flammable. See 9.3.3.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 9.1

Protective barrier



ULNORM.COM : Click to view the full PDF of UL 1610 2021

NOTES

A – The entire component under which a barrier (flat or dished 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 drop. 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 requires 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 (152 mm).

D – Minimum outline of the barrier, except that the extension (B) to (D) need not exceed 6 inches (152 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.

9.1.5 A construction using individual barriers under components, groups of components or assemblies, as illustrated in Figure 9.1 is considered to comply with the requirement in 9.1.3.

9.2 Doors and covers

9.2.1 An enclosure cover shall be hinged, sliding, or similarly attached so it cannot be removed if it gives access to fuses or any other overcurrent protective device, the intended functioning of which requires renewal; or if it is necessary to open the cover in connection with the intended operation of the unit.

Exception No. 1: If its position is supervised by a tamper contact that is connected in the closed protective circuit, an enclosure cover need not comply with the requirements of this paragraph. See also 31.5.

Exception No. 2: These requirements do not apply to a product located at a central-station.

9.2.2 Fasteners requiring the use of a tool or key shall be used for the assembly of all enclosures if access is not required for operation of the product.

Exception: This requirement does not apply to a product located at a central-station.

9.2.3 The cover of an enclosure shall be provided with a supervisory contact, connected in the closed protective wiring circuit, if it gives access to any relays, terminals, controls, or related components that might be subject to tampering without causing an alarm signal.

Exception: An enclosure located inside of a completely protected safe or vault, or at a central-station need not comply with this requirement.

9.3 Enclosure openings

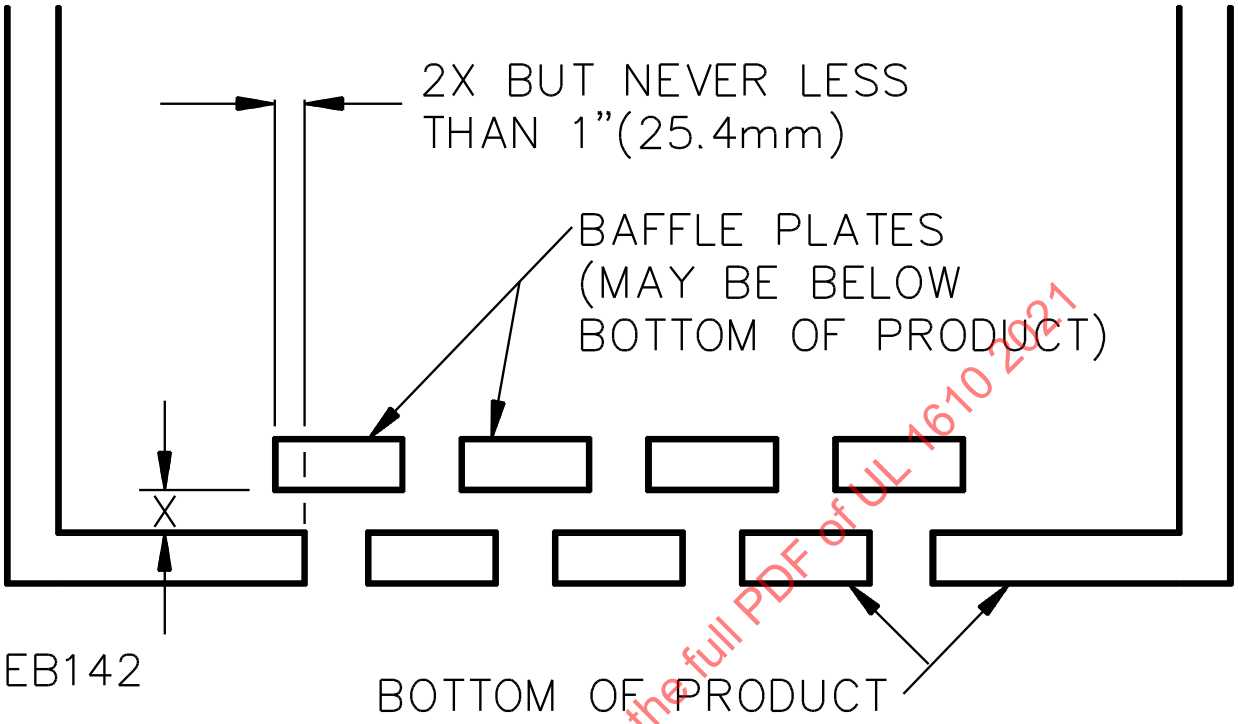
9.3.1 Openings in the enclosure shall be so constructed and of such size that direct entry of foreign objects is prevented. See also 7.2.3. See Figure 7.1 for examples of top cover constructions that may be used to prevent direct entry. See Figure 7.2 for examples of side opening constructions which may be used.

9.3.2 Openings may be provided in the bottom panels or protective barriers under areas containing materials not classified as V-1 or less flammable, in accordance with the Standard for Tests for Flammability of Plastic Materials for Use 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 9.2 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 round holes of 5/64 inch (2.0 mm) maximum diameter are spaced not closer together than 1/8 inch (3.2 mm) center-to-center. Constructions other than these two may be used if they comply with the Ignition Through Bottom-Panel Openings Tests, Section 50.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 9.2

Bottom panel baffles



ULNORM.COM : Click to view the full PDF of UL 1610 2021

9.3.3 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).

9.3.4 Openings may be used, without limitation on the size or number of openings, in areas containing only CTFE, FEP, PVC, TFE, and neoprene insulated wire or cable, in areas containing plugs and receptacles, and in areas underneath impedance protected or thermally protected motors.

9.3.5 Openings in the enclosure shall not give access to relays, terminals, controls, or related components that might be subject to tampering by hand or with tools without causing an alarm or trouble signal.

9.4 Screens and expanded metal

9.4.1 Screens or expanded metal used as a guard, enclosure, or part of an enclosure, shall comply with the requirements in 9.4.2 and 9.4.3, and the Mechanical Strength Tests for Enclosures, Section 51.

9.4.2 Perforated sheet steel and sheet steel used for expanded metal mesh shall be not less than 0.042 inch (1.07 mm) thick if uncoated or 0.046 inch (1.17 mm) thick if zinc-coated if the mesh openings or perforations are 1/2 square inch (323 mm^2) or less in area and shall be not less than 0.080 inch (2.03 mm) thick if uncoated or 0.084 inch (2.13 mm) thick if zinc-coated for larger openings. The largest dimension of this material 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 24, and the Mechanical Strength Tests for Enclosures,

Section 51), 0.021 inch (0.53 mm) expanded steel mesh or perforated sheet steel [0.023 inch (0.58 mm) if zinc coated] may be used, if:

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 covered by this material is not greater than 3-1/2 inches (89 mm).

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

9.5 Cast metal

9.5.1 The minimum thickness of cast metal for an enclosure shall be as indicated in Table 9.1.

Exception: Cast metal of lesser thickness may be used if, considering the shape, size, and function of the enclosure, the cast metal has been determined to provide the same level of mechanical strength. See the Drop Test, Section 48, and the Mechanical Strength Tests for Enclosures, Section 51.

Table 9.1
Cast-metal enclosures

Use, or dimensions of area involved[a]	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)	1/16[a]	(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) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

9.5.2 If threads for the connection of conduit are tapped through a hole in an enclosure wall, or if an equivalent construction is used, there shall be not less than 3-1/2 nor more than 5 threads in the metal, and the construction shall permit a standard conduit bushing to be attached as intended.

9.5.3 If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall be not less than 3-1/2 full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors that has been determined to provide the same level of protection to the conductors as that of a standard conduit bushing.

9.6 Sheet metal

9.6.1 The thickness of sheet metal for an enclosure shall be not less than that indicated in Table 9.2 or Table 9.3, whichever applies.

Exception: Sheet metal of lesser thickness may be employed if, considering the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See the Drop Test, Section 48, and the Mechanical Strength Tests for Enclosures, Section 51.

Table 9.2
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)	41.0	(104.1)	51.0	(129.5)	[14]		[14]	
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited		0.080	(2.03)	0.084	(2.13)
38.0	(96.5)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)	[13]		[13]	
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)	[12]		[12]	
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited		0.108	(2.74)	0.111	(2.82)
60.0	(152.4)	74.0	(188.0)	84.0	(213.4)	103.0	(261.6)	[11]		[11]	
63.0	(160.0)	Not limited		97.0	(246.4)	Not limited		0.123	(3.12)	0.126	(3.20)
73.0	(185.4)	90.0	(228.6)	103.0	(261.6)	127.0	(322.6)	[10]		[10]	

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which 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 which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

1) Single sheet with single formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame; for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece which 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.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 9.3
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)	inch	(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 which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which 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 which 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 formed flanges (formed edges),

2) A single sheet which is corrugated or ribbed, and

3) An enclosure surface loosely attached to a frame; for example, with spring clips.

[b] The width is the smaller dimension of a rectangular sheet metal piece which 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.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

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

9.6.3 A plate or plug closure for an unused conduit opening or other hole in the enclosure shall not be less than 0.027 inch (0.69 mm) thick if of steel or 0.032 inch (0.81 mm) thick if of nonferrous metal, for a hole having a 1-3/8 inch (34.9 mm) diameter maximum dimension.

9.6.4 A closure for a hole larger than 1-3/8 inch (34.9 mm) diameter shall have a thickness equal to that required for the enclosure of the product or a standard knockout seal shall be used. Such closures shall be securely mounted.

9.6.5 A knockout in a sheet metal enclosure shall be capable of being removed without excess deformation of the enclosure.

9.6.6 A knockout shall be provided with a surrounding surface of sufficient area to provide for seating of a conduit bushing and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those specified under Spacings, General, Section 24.

9.7 Product enclosure mounting

9.7.1 An enclosure shall have means for mounting that 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.

9.8 Polymeric materials

9.8.1 Among the factors to be taken into consideration when judging 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 shall be considered with respect to aging in accordance with the Polymeric Materials Test, Section 46, and the Mechanical Strength Tests for Enclosures, Section 51.

10 Corrosion Protection

10.1 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 means providing such protection. Bearing surfaces shall be of such materials and construction as to resist binding due to corrosion.

10.2 The requirement in 10.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

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 be likely to result in a risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons, or to 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.

10.3 Metals shall be galvanically compatible.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Exception: If galvanic action does not impair intended operation of the product, or result in the risk of fire, electric shock, or unintentional contact with moving parts that may cause a risk of injury to persons, this requirement does not apply.

10.4 Hinges and other attachments shall be resistant to corrosion.

FIELD IRING CONNECTIONS

11 General

11.1 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.

12 Cord-Connected Products

12.1 A portable product that is intended to be connected to high-voltage or line voltage shall be provided with not less than 6 feet (1.83 m) of flexible cord and a two- or three-prong attachment plug of a type rated for connection to the supply circuit.

Exception: The cord may be less than 6 feet in length if it is evident that the use of the longer cord may result in damage to the cord or product; may result in a risk of fire, electric shock, or injury to persons; may impair intended operation of the product; or is not required for the intended operation of the product.

12.2 A flexible cord may be used with a stationary product.

12.3 A flexible cord shall be of Type SJ, SJT, or equivalent, having conductors not smaller than 18 AWG (0.82 mm^2). It shall be rated for use at the voltage and ampacity rating of the product.

12.4 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 49.

12.5 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.

12.6 Clamps of any material (metal or otherwise) may be used on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

12.7 The supply cord or supply leads shall be prevented from being pushed into the unit through the cord-entry hole if such displacement is likely to:

a) Subject the cord or supply leads to mechanical damage or exposure to a temperature higher than that for which the cord or supply leads are rated,

b) Reduce spacings (such as to a metal strain-relief clamp) below the minimum required values, or

c) Damage internal connections or components.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

13 Permanently-Connected Products

13.1 General

13.1.1 A permanently-connected product shall have provision for connection of one of the wiring systems in accordance with the National Electrical Code, ANSI/NFPA 70.

13.1.2 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined as specified in Table 13.1.

Table 13.1
Trade size of conduit, inches (mm OD)

Wire size,		Number of wires									
AWG	(mm^2)	2		3		4		5		6	
14	(2.1)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)
12	(3.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
10	(5.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
8	(8.4)	3/4	(26.7)	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)
6	(13.3)	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)

NOTE – This table is based on the assumption that all conductors will be of the same size and there will not be more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

13.1.3 The location of a terminal box or compartment in which power supply connections are to be made shall permit the connections to be accessible without removal of parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

13.1.4 A terminal compartment intended for the connection of a supply raceway shall be secured in position and shall be prevented from turning.

13.1.5 The product shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than that required by the product. It is assumed that branch circuit conductors rated 60°C (140°F) will be used.

13.2 Field-wiring terminals

13.2.1 General

13.2.1.1 As specified in these requirements, field-wiring terminals are those terminals to which power supply (including equipment grounding) or control connections will be made in the field when the product is installed as intended.

13.2.1.2 A field wiring terminal shall comply with:

a) 13.2.2.1 – 13.2.2.5;

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

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

ULNORM.COM : Click to view the full PDF of UL 1610 2021

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 the Standard for Electrical Quick-Connect Terminals, 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.

13.2.1.3 A field-wiring terminal shall be prevented from turning or shifting in position. This may be accomplished by means such as two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part. Friction between surfaces shall not be used for preventing movement of the terminals.

13.2.2 General application

13.2.2.1 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for 8 AWG (8.4 mm^2) and larger wires. If the connectors or lugs are secured to a plate, the plate thickness shall not be less than 0.050 inch (1.27 mm). Securing screws may be plated steel.

13.2.2.2 A wire binding screw intended for connection of the power supply (line voltage) source shall not be smaller than No. 10 (4.8 mm diameter). The screw may be of plated steel.

Exception: A No. 8 (4.2 mm diameter) screw may be used for the connection of one 14 AWG (2.1 mm^2) and one No. 6 (3.5 mm diameter) screw may be used for the connection of one 16 AWG (1.3 mm^2) or smaller conductor.

13.2.2.3 For connection of other than power supply (line voltage) circuits using 10 AWG (5.3 mm^2) and smaller wires, a wire binding screw shall not be smaller than No. 8 (4.2 mm diameter), except that a No. 6 (3.5 mm diameter) screw may be used for the connection of one 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 one 19 AWG (0.65 mm^2) or smaller conductor.

13.2.2.4 Terminal plates tapped for wire binding screws shall:

a) Not have less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or that which has been determined to be equivalent, to hold the wires in position. Other constructions may be used if they provide equivalent thread security of the wire binding screw. However, two full threads are not required if fewer threads will result in a secure connection in which the threads will not strip with tightening torque in accordance with the values indicated in the Standard for Wire Connectors, UL 486A-486B.

b) Be of a nonferrous metal not less than 0.050 inch (1.27 mm) thick for a No. 8 (4.2 mm diameter) or larger screw, and not less than 0.030 inch (0.76 mm) thick for a No. 6 (3.5 mm diameter) or smaller screw.

13.2.2.5 If two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be used 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.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

13.2.3 Qualified application

13.2.3.1 Any of the following terminal configurations may be used for connection of field wiring, if they comply with all of the requirements in 13.2.3.2:

a) Push-In Terminals – Nonferrous (screwless) push-in terminals of the type used on some switches and receptacles wherein solid conductors may be pushed into slots containing spring-type retaining contacts. The leads can be removed by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals may not be used with aluminum conductors. See 100.15.

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.

Exception: A soldering lug, a push-in terminal, a screwless connector, or a quick-connect or similar friction fit connector shall not be used for the grounding terminal intended for the connection of field supply connections or for the grounding wire in a supply cord. See 14.4.

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

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

f) Other Terminals – Other terminal connections may be used if determined to be equivalent to (a) – (e) and limited to the same restrictions.

13.2.3.2 Any of the terminal configurations listed in 13.2.3.1 may be used for connection of field wiring if the construction complies with all of the following:

a) If a special tool is required for connection, its use shall be indicated on the installation wiring diagram. See 100.4.

b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size shall not be smaller than 22 AWG (0.32 mm^2).

c) The wire size to be used shall have the current-carrying capacity of the circuit application.

d) The terminal configuration shall comply with the requirements in the Special Terminal Assemblies Tests, Section 52.

Exception: Terminals complying with the requirements in any of the standards specified in 13.2.1.2 (b) – (e) are not required to be subjected to the Special Terminal Assemblies Tests, Section 52.

13.3 Field wiring leads

13.3.1 If leads are provided in lieu of wiring terminals, they shall have a minimum free lead length of 6 inches (152 mm), and shall not be smaller than 22 AWG (0.32 mm^2).

Exception No. 1: A lead may be less than 6 inches long if it is evident that the use of a longer lead may result in damage to the lead insulation or product; may result in a risk of fire, electric shock, or injury to persons; may impair intended operation of the product; or is not required for the intended operation of the product.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

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 ampere 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 requirement in 49.2.1 for strain relief, and

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

13.3.2 Leads intended for connection of a line voltage source shall not be smaller than 18 AWG (0.82 mm^2).

13.3.3 Leads intended for connection to an external circuit shall comply with the strain relief test specified in 49.2.1.

13.4 Polarity identification

13.4.1 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 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.

13.4.2 A terminal intended for the connection of a grounded supply conductor shall be composed of or plated with metal that is substantially 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.

14 Grounding

14.1 A grounding means shall be provided for all equipment containing parts that require grounding. See Bonding for Grounding, Section 18.

14.2 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 of the product.

b) In a product intended be permanently connected by a nonmetallic-enclosed wiring system, such as nonmetallic-sheathed cable, an equipment grounding terminal or lead.

c) In a cord-connected product, an equipment grounding conductor in the cord.

14.3 On a permanently-connected product, a terminal intended solely for the connection of an equipment grounding conductor shall be capable of securing a conductor of the size rated for the application in accordance with the National Electrical Code, ANSI/NFPA 70.

14.4 A soldering lug, a push-in terminal, a screwless connector, or a quick-connect or similar friction fit connector shall not be used for the grounding terminal intended for the connection of field supply connections or for the grounding wire in a supply cord.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

14.5 On a permanently-connected product, 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 with a grounding symbol determined to be equivalent; or by a marking on a wiring diagram provided on the product. See also 14.6. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the product and shall be located so that it is unlikely to be removed during service operations, such as replacing fuses, resetting manual-reset devices, or the like.

14.6 If a pressure wire connector intended for grounding is located where it could be mistaken for a neutral conductor of a grounded supply, it shall be identified by a marking "EQUIPMENT GROUND" or with a green color identification or both.

14.7 On a permanently-connected product, 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 field wiring lead shall be so identified.

14.8 On a cord connected product, the grounding conductor of the flexible cord shall be finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the product by a positive means (see Bonding for Grounding, Section 18) that is not likely to be removed during any servicing operation not involving the power supply cord. The grounding conductor shall be connected to the grounding blade of the attachment-plug.

14.9 The screw mentioned in 14.5 shall be of corrosion resistant metal, or shall be protected against corrosion in a manner that will not inhibit electrical conductivity between the screw and any other conductor. A lock washer shall be used to prevent the screw from becoming loosened by vibration.

14.10 If a product is provided with a power-supply cord or cord set incorporating a separable cord connector body, and has conductive parts that are connected to the grounding conductor and that might be contacted by a person during the connection or disconnection of the cord connector body at the product end of the cord, the construction shall be such that the grounding connection is made first and broken last with respect to the power supply conductors.

14.11 A grounding adapter included with a product equipped with a grounding type supply cord shall be marked or tagged with instructions for its proper use. The adapter shall not be attached to the attachment plug during shipment to the user.

14.12 A dual voltage rated appliance (such as 120/240 volts) using a grounding type supply cord shall be provided with a 120/240-volt grounding type adapter tagged with instructions for its proper use.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

INTERNAL WIRING

15 General

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

15.2 Leads or a cable assembly connected to parts mounted on a hinged cover shall be of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. The

leads shall be secured or equivalently arranged to reduce the risk of abrasion of insulation and jamming between parts of the enclosure.

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

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

16 Wiring Methods

16.1 All splices and connections shall be mechanically secure and electrically bonded.

16.2 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or arranged in a construction that has been determined to be the equivalent.

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

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

16.5 A printed-wiring assembly employing insulating coatings or encapsulation shall comply with the requirements in the Dielectric Voltage-Withstand Test, Section 41, before and after being treated. If it is impractical to use untreated samples, finished samples shall comply with the requirements in the Dielectric Voltage-Withstand Test after they are subjected to the Humidity Test, Section 35; the Temperature Test, Section 42; and other applicable tests described in this standard.

16.6 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.

16.7 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.

16.8 Ceramic materials and some molded compositions may be used for insulating bushings if they have been investigated and determined to be equivalent for the purpose.

16.9 Fiber may be used where it will not be subjected to temperatures 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 if it will not be exposed to moisture.

16.10 A soft rubber bushing may be used in the frame of a motor if the bushing is not less than 3/64 inch (1.2 mm) thick and if the bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substance which may have a deleterious effect on rubber. If a soft rubber bushing is used in a hole in metal, the hole shall be free from sharp edges, burrs, projections, and the like, which would be likely to cut into the rubber.

16.11 An insulating-metal grommet may be used in lieu of an insulating bushing, if 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.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

17 Separation of Circuits

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

17.2 A barrier used to provide separation between the wiring of different circuits shall be of metal or of insulating material. A barrier of insulating material shall not be less than 0.028 inch (0.71 mm) thick. Any clearance between the edge of a barrier and a compartment wall shall not be more than 1/16 inch (1.6 mm).

18 Bonding for Grounding

18.1 In a product intended for connection to a high-voltage source, provision shall be made for the grounding of all exposed or accessible noncurrent-carrying metal parts which are likely to become energized and that may be contacted by the operator, user, or by service personnel during operations likely to be performed while the product is energized.

18.2 Uninsulated metal parts, such as cabinets, electrical enclosures, capacitors and other electrical components, shall be bonded for grounding if they may be contacted by the operator, user, or service person, except as indicated in 18.3.

18.3 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, that are physically separated from wiring and uninsulated live parts.

c) Cabinets, panels, and covers that do not enclose uninsulated live parts, if wiring is physically separated from the cabinet, 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. If material having a lesser thickness is used, consideration shall be given to such factors as its electrical, mechanical, and flammability properties when compared with materials in thicknesses specified above.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

18.4 The resistance between the point of connection of the equipment grounding means, at or within the unit, and any other point in the grounding circuit shall be not more than 0.1 ohm.

18.5 Any appropriate instrument may be used to determine whether a product complies with the requirement in 18.4, but if noncompliant results are obtained from a circuit not including the grounding conductor of a power supply cord, an alternating current (60 hertz) of at least 25 amperes from a power supply of not more than 12 volts is to be passed from the point of connection of the equipment grounding means to a point in the grounding circuit, and the resulting drop in potential is to be measured between the two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

18.6 The metal enclosure of a product having a slide-out chassis is considered to be grounded if the resistance between the point of connection of the equipment grounding means and enclosure does not exceed 0.1 ohm. Unless a separate grounding conductor is used, all nonconductive coatings between the enclosure and equipment grounding means shall be penetrated when the chassis is inserted in the

enclosure. In such cases, metal-to-metal contact shall be maintained at any point of insertion or withdrawal of the chassis.

18.7 Metal-to-metal hinge bearing members for a door or cover are considered to be a means for bonding a door or cover for grounding if a minimum of two pin-type hinges are used, each with a minimum of three knuckles, or the hinges are continuous (piano-type).

18.8 A separate component-bonding conductor shall be of copper, a copper alloy or other material that has been determined acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings, such as enameling, galvanizing or plating. A separate bonding conductor or strap shall be protected from mechanical damage or be located within the confines of the outer enclosure or frame, and shall not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

18.9 The bonding shall be by a positive means, such as by clamping or riveting, by bolted or screwed connections; or by welding, soldering and brazing materials having a softening or melting point greater than 445° C (833° F). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or other nonmetallic material.

Exception: A connection that depends upon the clamping action exerted by rubber or other nonmetallic material may be used if it complies with 18.12.

18.10 With reference to 18.9, a bolted or screwed connection that incorporates a star washer under the screwhead, or a serrated screwhead may be used for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

18.11 An internal connection for bonding internal components to the enclosure for grounding, but not for a field-installed grounding conductor or for the grounding wire in a supply cord, may use a quick-connect terminal of the specified dimensions if it is not likely to be displaced and the component is limited to use on a circuit having a branch circuit protective device rated as specified in Table 18.1.

Table 18.1
Internal terminal connections for bonding

Terminal dimensions, inches	Terminal dimensions, (mm)	Rating of protective device, amperes
0.020 by 0.187 by 0.250	(0.51 by 4.75 by 6.35)	20 or less
0.032 by 0.187 by 0.250	(0.81 by 4.75 by 6.35)	20 or less
0.032 by 0.205 by 0.250	(0.81 by 5.2 by 6.35)	20 or less
0.032 by 0.250 by 0.312	(0.81 by 6.4 by 7.92)	60 or less

18.12 A connection that depends upon the clamping action exerted by rubber or other nonmetallic material may be used if it complies with 18.15 under any intended degree of compression resulting from the use of a variable clamping device and if the material's intended performance is not impaired after exposure to the effects of oil, grease, moisture, and thermal degradation which may occur in service. Also, the effect of assembling and disassembling such a clamping device for maintenance purposes is to be considered, with particular emphasis on the likelihood of the clamping device being reassembled in its intended fashion.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

18.13 On a cord-connected product, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord. See also 18.16 and 18.17.

18.14 On a permanently-connected product, the size of a conductor used to bond an electrical enclosure shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. The size of the conductor or strap shall be in accordance with Table 18.2. An equipment grounding conductor is not required to be larger than the circuit conductors supplying the equipment.

Table 18.2
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.

18.15 A conductor such as a clamp or strap used in place of a separate wire conductor as indicated in 18.14, may be used if the minimum cross-sectional conducting area is equivalent to the wire sizes specified in Table 18.2.

18.16 A bonding conductor to an electrical component need not be larger than the size of the conductors supplying the component.

18.17 Splices shall not be used in wire conductors used to bond electrical enclosures or other electrical components.

18.18 If more than one size branch circuit overcurrent protective device is involved, the size of the bonding conductor shall be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a component is individually protected by a branch circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding conductor for that component shall be sized on the basis of the overcurrent device intended for ground-fault protection of the component.

18.19 The continuity of the grounding system of the product shall not rely on the dimensional integrity of nonmetallic material.

18.20 It may not be practical to connect certain conductive parts (control shafts, mounting screws, and the like) described in 18.1 to the grounding means. Such parts are not considered likely to become energized if supplementary insulation is used in addition to the functional insulation, as defined in 18.21, provided. Where it is impractical to provide separate functional insulation and supplementary insulation, the functional insulation may be replaced by more substantial insulation. Such reinforced insulation shall comply with the requirements in 18.23.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

18.21 Functional insulation is defined as the insulation necessary for the proper functioning of the product and for basic protection against electric shock, and shall have:

a) A dielectric voltage-withstand capability of 1000 volts for 1 minute and

b) Minimum required through-air or over surface spacings of 1/16 inch (1.6 mm).

18.22 The thickness, insulation qualities, and the resistance to deterioration as a result of aging of material used as supplementary insulation shall not be less than would be required for the same material used as functional insulation. The minimum thickness of supplementary insulation shall be 1/32 inch (0.8 mm) and this insulation shall have a dielectric voltage withstand capability of at least 2500 volts for 1 minute. The minimum acceptable through-air or over surface spacing between conductive parts separated by supplementary insulation shall be 1/16 inch (1.6 mm).

18.23 The insulation qualities and resistance to deterioration as a result of aging of materials used as reinforced insulation shall be less than the total that would be required for the combination of functional and supplementary insulation. The minimum thickness of reinforced insulation shall be 5/64 inch (2 mm) and this insulation shall have a dielectric voltage-withstand capability of at least 3500 volts for 1 minute. The minimum required through-air or over surface spacing between live parts and accessible conductive parts separated by reinforced insulation shall be 1/8 inch (3.2 mm).

18.24 A convenience receptacle provided on a product intended to be grounded shall be of a grounding type. The grounding contact of the receptacle shall be electrically connected to the grounding means of the product.

COMPONENTS, ELECTRICAL

19 General

19.1 Mounting of components

19.1.1 A switch, lampholder, attachment-plug, connector base, or similar electrical component shall be secured in position and, except as noted in the following paragraphs, shall be prevented from turning.

19.1.2 The requirement that a switch be prevented from turning may be waived if the construction complies with all of the following:

a) The switch is a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during intended operation of the switch.

b) The means for mounting the switch make it unlikely that the operation of the switch will loosen it.

c) Spacings are not reduced below the minimum required values if the switch rotates.

d) The operation of the switch is by mechanical means rather than by direct contact by persons.

19.1.3 A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation will not reduce spacings below the minimum required values.

19.1.4 Uninsulated live parts shall be so secured to the base or mounting surface so that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the acceptable values. Securing of contact assemblies shall provide for the continued alignment of contacts.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

19.1.5 The means for preventing turning shall not only consist of friction between surfaces.

19.1.6 A lock washer which provides both spring take-up and an interference lock may be used as the means for preventing from turning a small stem-mounted switch or other device having a single-hole mounting means.

19.1.7 A flush plate for outlet-box mounting shall be of 0.030 inch (0.76 mm) or thicker ferrous metal, of 0.040 inch (1.02 mm) or thicker nonferrous metal, or of 0.100 inch (2.54 mm) or thicker nonconductive material.

19.1.8 A yoke, strap, or the mounting ears of a part intended to be mounted on a standard outlet box or similar back box shall be of 0.040 inch (1.02 mm) or thicker steel. If a nonferrous metal is used, it shall be of thickness sufficient to provide mechanical strength and rigidity equivalent to that of 0.040 inch thick steel.

19.2 Insulating materials

19.2.1 An insulating 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. See the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

19.2.2 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 which 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.

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

19.2.4 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 not be less than 1/8 inch (3.2 mm).

19.2.5 The thickness of a flat sheet of insulating material, such as phenolic composition or the equivalent, used for panel-mounting of parts shall not be less than that indicated in Table 19.1.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 19.1
Thickness of flat sheets of insulating material

Maximum dimensions				Minimum thickness,	
Length or width,		Area,			
inch	(cm)	inch^2	(cm^2)	inch	(mm)
24	(61)	360	(2322)	3/8[a]	(9.5)[a]
48	(122)	1152	(7432)	1/2	(12.7)
48	(122)	1728	(11148)	5/8	(15.9)
Over 48	(122)	Over 1728	(11148)	3/4	(19.1)

[a] Material less than 3/8 inch (9.5 mm) but not less than 1/8 inch (3.2 mm) thick may be used for a panel if the panel is 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 (3.2 mm) may be used for subassemblies, such as supports for terminals for internal wiring, resistors, and other components.

19.3 Fuseholder

19.3.1 A fuseholder shall be installed or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. A separation of less than 4 inches (102 mm) is considered to be adjacent.

19.4 Current-carrying parts

19.4.1 All current-carrying parts shall be of silver, copper, a copper alloy, or other material determined to be acceptable for use as an electrical conductor.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not comply with this requirement.

19.4.2 Bearings, hinges, and the like shall not be used as current-carrying parts.

20 Overcurrent Protection

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

21 Semiconductors

21.1 Semiconductors shall be rated for the intended application under all environmental conditions to which they may be exposed in service. See Performance Tests, Sections 26 – 52.

22 Switches

22.1 A switch provided as part of the product shall have a current and voltage rating not less than that of the circuit 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 (evaluated on the basis of the ampere equivalent), or a rating of not less than 200 percent of the maximum load current.

23 Transformers and Coils

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

Exception: An autotransformer may be used, if the terminal or lead common to both input and output circuits is identified as being intended for connection to the grounded conductor, and the output circuits are located only within the enclosure containing the autotransformer. See 13.4.1.

23.2 Coils shall be treated with an insulating varnish, and baked or otherwise impregnated to exclude moisture.

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

SPACINGS

ULNORM.COM : Click to view the full PDF of UL 1610 2021

24 General

24.1 Spacings between uninsulated live parts and between uninsulated live parts and dead metal parts shall not be less than those indicated in 24.2 – 24.5.

24.2 The spacing between an uninsulated live part and a:

a) Wall or cover of a metal enclosure,

b) Fitting for conduit or metal-clad cable, and

c) Metal piece attached to a metal enclosure,

where deformation of the enclosure is likely to reduce spacings, shall not be less than the values indicated in Table 24.1. See Figure 24.1.

Table 24.1
Minimum spacings

Point of application	Minimum spacings				
	Voltage range, 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:					
(General application)[a]	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)
Installation wiring terminals, except solder-type terminals (special application, see 13.2.3.1)	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:[b]					
100 volt-amperes maximum	0 – 30	1/32[c]	(0.8)	1/32[c]	(0.8)
Over 100 volt-amperes	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)	1/16	(1.6)
	31 – 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)

[a] Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. In no case shall the wire be smaller than 18 AWG (0.82 mm^2).

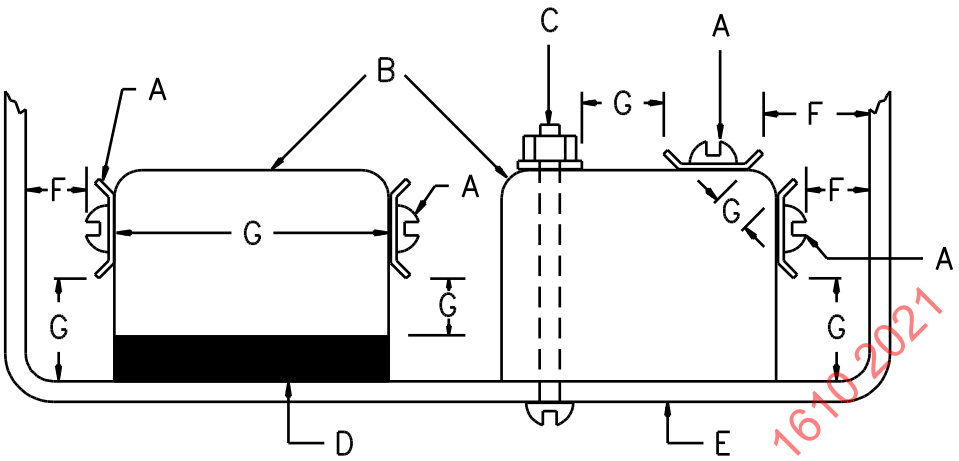
[b] Rigidly clamped assemblies include such parts as contact springs on relays or cam switches, printed-wiring boards, and the like.

[c] 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).

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 24.1

Component spacings



SM100

A – Uninsulated live parts of a component.

B – Insulating materials of a component.

C – Mounting screw of a component.

D – Dead metal part of a component.

E – Dead metal part of the product.

F – Spacings to which the requirements of this standard apply unless specifically noted otherwise.

G – Spacings to which the requirements in this standard may not apply.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

24.3 The spacings between an uninsulated live part and an:

a) Uninsulated live part of opposite polarity,

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

c) Exposed dead metal part which is isolated (insulated)

shall not be less than those indicated in Table 24.1. See also 25.1 and 25.2 and Figure 24.1.

24.4 If a short circuit between uninsulated live parts of the same polarity would prevent the intended operation of the product without simultaneously producing an alarm signal, the spacings between such parts shall not be less than those indicated for other parts in Table 24.1.

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

25 Components

25.1 A galvanometer-type relay in which the spacings do not comply with 24.2 may be used if, upon investigation, it complies with the performance requirements in this standard.

25.2 Minimum values of spacings are not specified for vacuum tube and semiconductor sockets and similar related component parts, such as vacuum tubes, semiconductors, potentiometers, and the like, used in electronic circuits. However, if the spacings in such components do not comply with the requirements in 24.2 – 24.5, the spacings shall be such that the circuit complies with the Dielectric Voltage-Withstand Test, Section 41.

25.3 The spacings within snap switches, lampholders, and similar wiring devices supplied as part of a unit are investigated on the basis of the requirements for such devices.

PERFORMANCE – ALL UNITS

26 General

26.1 Test units and data

26.1.1 Central-station burglar-alarm units that are fully representative of production units are to be used for the tests described in Sections 27 – 52 unless otherwise specified.

26.1.2 The devices used for testing are to be those specified by the wiring diagram of the product, except that 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.

26.2 Test samples and miscellaneous data

26.2.1 The following shall be provided for testing:

a) Two or more complete central-station burglar-alarm units.

Exception: A single sample may be provided if the size and complexity of the product would make it impracticable to provide more than one sample. The single sample shall be fully representative of the product.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

b) One or more samples of each encapsulated or sealed assembly are to be provided in the unencapsulated or unsealed condition.

c) Installation and operating instructions (see 4.1 and 4.2).

26.3 Test voltages

26.3.1 Unless specifically noted otherwise, the test voltage for each test of a product shall be at the rated frequency as specified in Table 26.1.

Table 26.1
Voltage for tests

Voltage rating of product	Test potential, volts
110 – 120	120
220 – 240	240
Other	Marked rating

ULNORM.COM : Click to view the full PDF of UL 1610 2021

26.4 FCC requirements

26.4.1 A product radiating or utilizing radio frequency energy shall comply with the regulations of the Federal Communications Commission (FCC) before it is submitted for test. A letter of certification or the equivalent from the FCC is required as evidence of compliance.

27 Normal Operation Test

27.1 A unit shall perform its intended function when installed in accordance with 27.2.

27.2 The unit is to be mounted in the intended manner and its terminals connected to circuits of related equipment as indicated by the installation wiring diagram so as to represent a typical system combination.

27.3 If equipment must be mounted in a definite position in order to function as intended, it is to be tested in that position.

27.4 Power-input supply terminals shall be connected to supply circuits of rated voltage and frequency. A product under test shall be in the circuit condition ready for intended signaling operation when it is connected to related products and circuits as specified in 27.2 and 27.3.

27.5 When installed as recommended by the manufacturer, a product shall not be subject to false operation and shall be positive in its operation.

28 Incorrect Connection Tests

28.1 There shall be no internal damage to circuitry if field wiring terminals are shorted together or are connected to power supply terminals. See also 28.4.

28.2 A power source of rated test voltage is to be connected between the terminal under test and ground. See 26.3.1.

28.3 There shall be no internal damage to circuitry if all connections to power terminals and input and output lines are reversed as pairs, reversed individually, or individually connected to any terminal adjacent to the one to which it is intended to be connected. See also 28.4.

28.4 If damage can result from incorrect connection, markings shall be provided, clearly visible to the installer during installation, that warn of consequences of improper connection. If correct polarity is required, polarity markings shall appear immediately adjacent to wiring terminals.

29 Input Test

29.1 The input to 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 source of supply in accordance with the requirements in 29.2.

29.2 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.

30 Output Measurement Test

30.1 The measured output voltage of a central-station burglar-alarm unit shall be within the limits specified in Table 30.1 while the unit is connected to a source of supply as specified in 26.3.1.

Exception: The limits of Table 30.1 do not apply if a product specified to be connected to an output voltage operates as intended at all voltage levels.

Table 30.1
Output voltage limits

No load			Full load		
85 percent rated input	**100 percent rated input**	**110 percent rated input**	**85 percent rated input**	**100 percent rated input**	**110 percent rated input**
85 to 110.5 percent of rated maximum	100 to 130 percent of rated maximum	100 to 143 percent of rated maximum	85 to 100 percent of rated maximum	100 to 110 percent of rated maximum	100 to 110 percent of rated maximum

30.2 The measured voltages at the output circuits, with the minimum and maximum rated loads applied in turn, shall be compatible with the rating of the product intended to be connected to the circuit.

30.3 The output circuits in a central-station burglar-alarm unit shall be power limited. See 3.5.

Exception: This requirement does not apply to an output circuit using a connecting device or other method recognized for high-voltage wiring, such as a 125 volt, 15 ampere, parallel blade receptacle.

30.4 To determine if the output capacity of an inherently limited power source complies with the requirements of 30.3, a variable resistive load is to be connected to a circuit to simulate all loads that are intended to obtain their energy from that circuit. With the product connected to a rated source of supply as specified in 26.3.1, the resistive load is to be varied between open circuit and short circuit conditions in not less than 1-1/2 nor more than 2-1/2 minutes. Voltage and current measurements are to be recorded for each value and the maximum volt-amperes calculated. If an overcurrent protective device is provided, it may be shunted out during the test, if necessary.

31 Electrical Supervision Test

31.1 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, or the product shall be provided with a test feature as described in 31.3.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

31.2 A malfunction of the power supply or loss of both primary power and standby battery capability shall result in an alarm or trouble signal.

31.3 A manual test feature provided as a part of the operation of the system that effectively tests the capability of critical components or the battery may be used in lieu of electrical supervision.

31.4 With reference to the requirements in 31.3, a "critical component" is defined as a component whose malfunctioning will impair the operation of the product or will cause a risk of fire or electric shock.

31.5 Any cover, door, or access panel shall be electrically supervised (protected) if it gives access to any relays, terminals, controls, or related components that might be subject to tampering, so that opening or removal shall result in an alarm or trouble signal. See 54.2 and 54.3.

Exception: This requirement does not apply to equipment located at a central-station.

32 Undervoltage Operation Test

32.1 A central-station burglar-alarm unit shall operate for its intended signaling performance while energized at 85 percent of its rated voltage.

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

32.3 A product that uses batteries for principal 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.

32.4 A product that uses primary or secondary batteries for standby power shall be tested for operation at 85 percent of nominal battery voltage while operating from standby power.

32.5 If the maximum impedance of an initiating device circuit extended from a product is required to be less than 100 ohms in order to obtain intended operation, maximum impedance is to be connected to the circuit during this test. If no impedance limitation is indicated in the installation instructions, an impedance of 100 ohms is to be used in the initiating device circuit.

33 Overvoltage Operation Test

33.1 A central-station burglar-alarm unit shall withstand 110 percent of its rated supply voltage without damage during the standby condition and shall operate for its intended signaling performance at the increased voltage.

33.2 The product is to be subjected to the increased voltage in the standby condition and then tested for its intended signaling performance. For this test, a 0-ohm line impedance shall be used in the initiating device circuit.

34 Variable Ambient Test

34.1 A central-station burglar-alarm unit shall function as intended at the test voltage and at ambient temperatures of 0 and 49°C (32 and 120°F). The exposure to either of these temperatures shall be for a minimum of 4 hours.

Exception: A product intended for use in a central-station equipped with heating and air conditioning systems, and a secondary power supply to maintain the operation of these systems, may be exposed to

ULNORM.COM : Click to view the full PDF of UL 1610 2021

temperatures of 13 and 35° C (55 and 95° F). The installation instructions of a product tested at these temperatures shall indicate these necessary conditions. See 100.1(o). These products need not comply with the requirements in the Humidity Test, Section 35, but shall comply with the requirements in the Leakage Current Tests for High-Voltage Cord-Connected Products, Section 36, but without humidity conditioning. This exception does not apply to products that are intended to be used in a satellite station, a repeater station, or a protected premise.

35 Humidity Test

35.1 A central-station burglar-alarm unit shall function as intended during and after exposure for 24 hours to air having a relative humidity of 85 ±5 percent and a temperature of 30 ±2°C (86 ±3°F).

35.2 Cord-connected products powered from a high-voltage source shall comply with the applicable requirements in the Leakage Current Tests for Cord-Connected Products, Section 36, immediately following exposure to the environment specified in 35.1.

36 Leakage Current Tests for Cord-Connected Products

36.1 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 interconnected to a product accessible to contact by a person, shall not exceed the values specified in Table 36.1, when tested in accordance with the requirements in 36.7 and 36.8, immediately after exposure to the Humidity Test, Section 35.

Table 36.1
Maximum leakage current

Type of product[a]	Maximum leakage current,[b] mA
2-wire cord-connected product	0.50
3-wire (including grounding conductor) cord-connected, portable product	0.50
3-wire (including grounding conductor) cord-connected stationary or fixed product	0.75

[a] Products which incorporate a loss-of-ground detector which dependably opens the live conductors are exempted from the requirements in this table.

[b] If an electromagnetic radiation suppression filter is necessary for the equipment to function as intended, the leakage current shall not be more than 2.5 milliamperes if the equipment complies with the following conditions:

1. The equipment is provided with grounding means in accordance with the applicable requirements for cord-connected equipment in 14.1– 14.12.

2. With the filter removed from the equipment, the leakage current does not exceed the limits specified in this table, as applicable.

3. The equipment is marked in accordance with 100.14.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

36.2 For this test, the product is to be de-energized, removed from the humidity environment, placed on a dry insulating surface, and immediately reenergized from a rated source of supply in accordance with 26.3.1. Leakage current measurements are to be made with the product in the standby and operating conditions.

36.3 With reference to the requirements in 36.1, leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces and ground or other exposed conductive surfaces.

36.4 All exposed conductive surfaces are to be tested for leakage currents. Where these surfaces are simultaneously accessible, leakage currents from these surfaces are to be measured 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 considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time.

36.5 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil with an area of 100 by 200 millimeters (3.94 by 7.87 inches) in contact with the surface. If 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.

36.6 The measurement circuit for leakage current is to be as illustrated in Figure 36.1. The measurement instrument is described in (a) – (c). The meter used for a measurement need only indicate the same numerical value for a particular measurement as would the described instrument and need not have all of the attributes of the described instrument.

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

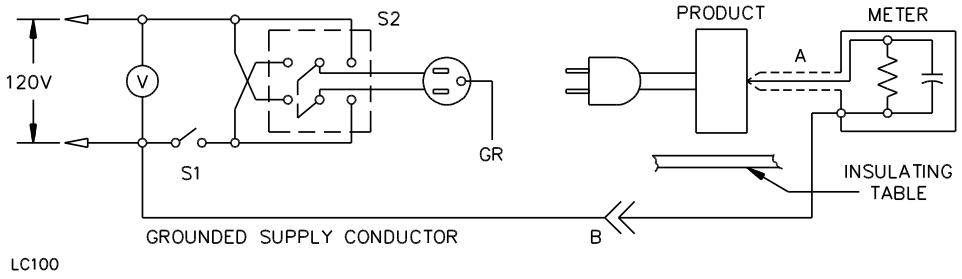
b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kHz, 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.

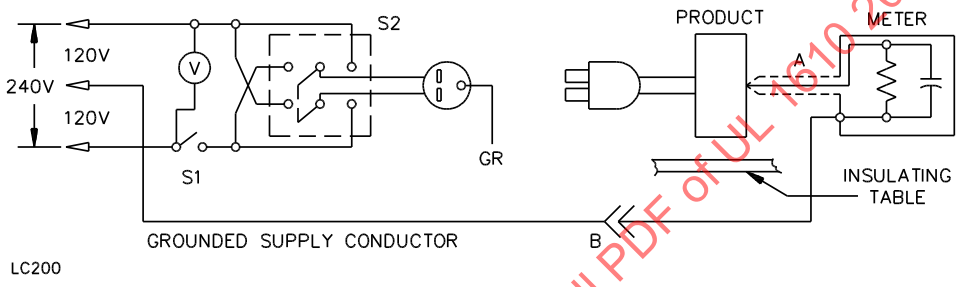
ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 36.1

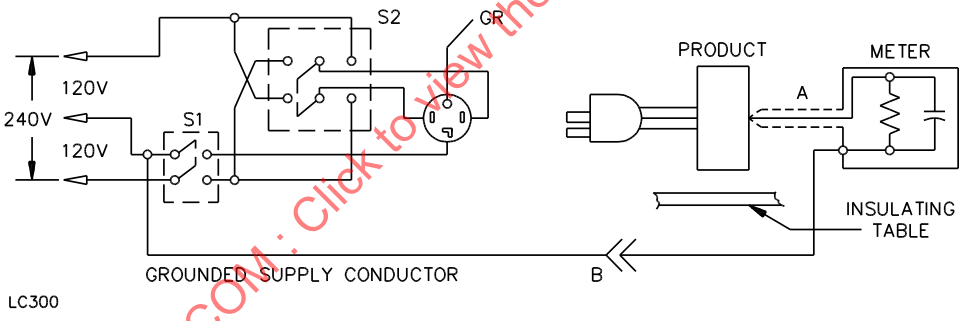
Leakage current measurement circuits



Circuit A: Product intended for connection to a 120 or 208 volt power supply.



Circuit B: 240 or 208 volt product intended for connection to a 3-wire, grounded neutral power supply.



Circuit C: 240 or 208 volt product intended for connection to a 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.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

36.7 The supply voltage is to be adjusted to the test voltage in accordance with 26.3.1.

36.8 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 product in its wiring methods, routing, components, component location and installation, and the like.

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 35.1.

36.9 The leakage current test sequence, with reference to the measuring circuit illustrated in Figure 36.1, 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 on the product are to be operated in their intended manner, and leakage currents are again to be measured using both positions of switch S2.

b) With the product switching devices in their intended operating positions, switch S1 is then 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 on the product are then to be operated in their intended manner, and leakage currents measured using both positions of switch S2.

c) The product switching devices are then to be returned to their intended operating positions and the product allowed to operate until the leakage current is determined to be constant or decreasing in value. Both positions of switch S2 are to be used in determining this measurement.

d) Immediately after 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. Measurements are to be made with switch S2 in both positions.

37 Electric Shock Current Test

37.1 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 in 37.2 – 37.4, as applicable.

37.2 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 37.1 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 37.1
Maximum current during servicing

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

Table 37.1 Continued on Next Page

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 37.1 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 determined the maximum current corresponding to frequencies not shown. The table applies to repetitive nonsinusoidal or sinusoidal waveforms.

37.3 The duration of a transient current flowing through a 500-ohm resistor connected as described in 37.2 shall not exceed:

a) The value determined by the following equation:

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

in which:

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

I is the peak current in milliamperes; 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 transient current duration are shown in Table 37.2.

Table 37.2
Maximum transient current

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 37.2 Continued on Next Page

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 37.2 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

37.4 The maximum capacitance between the terminals of a capacitor during operator servicing shall comply with the following equations:

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

$$C = 35,288E - 1.5364 \quad for \quad 400 \le E \le 1000$$

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 37.3.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 37.3
Electric shock – stored energy

Potential across capacitance prior to discharge, volts	Maximum capacitance, microfarads
1,000	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	124.0
45	150.0
42.2	169.0

ULNORM.COM : Click to view the full PDF of UL 1610 2021

37.5 With reference to the requirements in 37.2 and 37.3, the current is to be measured while the resistor is connected between ground and:

a) Each accessible part individually,

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.

37.6 With reference to the requirements in 37.5, parts are considered to be simultaneously accessible if they can be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is considered to be able to contact parts simultaneously if the parts are within a 4- by 8-inch (102- by 203-mm) rectangle, and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 6 feet (1.8 m) apart.

37.7 Electric shock current refers to all currents, including capacitively coupled currents.

37.8 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.

37.9 Current measurements are to be made:

a) With any operating control, or adjustable control that is subject to user operation, in all operating positions and

b) 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.

38 Overload Test

38.1 General

38.1.1 A central-station burglar-alarm unit other than that operating from a primary battery shall operate as intended after 50 cycles of operation at a rate of not more than 15 cycles per minute while connected to a source of supply adjusted to 115 percent of the rated test voltage. Each cycle is to begin with the product energized in the standby condition, followed by intended operation, and then restoration to standby condition.

38.1.2 Rated test loads are to be connected to the output circuits of the product. The test loads are to be remote indicators, relays, or the equivalent. If an equivalent load is used to simulate an inductive component, a power factor of 60 percent is to be used. The rated loads are to be established with the product initially connected to a source of supply in accordance with the requirements of 26.3.1 following which the voltage is to be increased to 115 percent of the initial value.

38.1.3 For DC circuits, an equivalent inductive test load shall have the:

a) Required DC resistance for the test current and

b) Inductance (calibrated) necessary to obtain a power factor of 60 percent when connected to a 60-Hertz AC rms voltage equal to the rated DC test voltage.

The resultant AC current shall be equal to 60 percent of the DC current when the load is connected first to an AC voltage and then to a DC voltage equal to the rms value of the AC source.

38.2 Separately energized circuits

38.2.1 Separately energized circuits that do not receive energy from the product, such as dry contacts, shall operate as intended after 50 cycles of signal operation at a rate of not more than 15 cycles per minute while connected to a voltage source in accordance with the requirements of 26.3.1 and with 150 percent rated current loads at 60 percent power factor applied to the output circuits.

38.2.2 The test loads shall be adjusted to draw 150 percent of their rated current while connected to a separate source of supply in accordance with 26.3.1.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

39 Endurance Test

39.1 General

39.1.1 A central-station burglar-alarm unit shall operate at rated voltage and current for the number of cycles indicated in Table 39.1. Each cycle shall consist of setting, tripping, and restoration to standby. The rate of operation shall:

a) Not be more than 15 cycles per minute or the product's rated speed of operation, whichever is faster, for a product designed to operate repeatedly or

b) Be 2 pulses per second for a product receiving a signal from a code transmitter.

At the completion of the test, the product shall be mechanically and electrically operable and shall perform its intended function.

Table 39.1
Cycles of operation

Product	Number of cycles
Subscriber's control unit	6000
Direct-wire receiving unit	6000
Code transmitter receiving unit and register	500,000 pulses
Alarm printer	500,000 lines
Multi-function receiving processor	30,000

ULNORM.COM : Click to view the full PDF of UL 1610 2021

39.2 Separately energized circuits

39.2.1 Separately energized circuits that do not receive energy from the product shall operate as intended following the applicable Endurance Test specified in 38.1.1 while connected to a source of supply in accordance with 26.3.1 and with rated load at 60 percent power factor applied to output circuits.

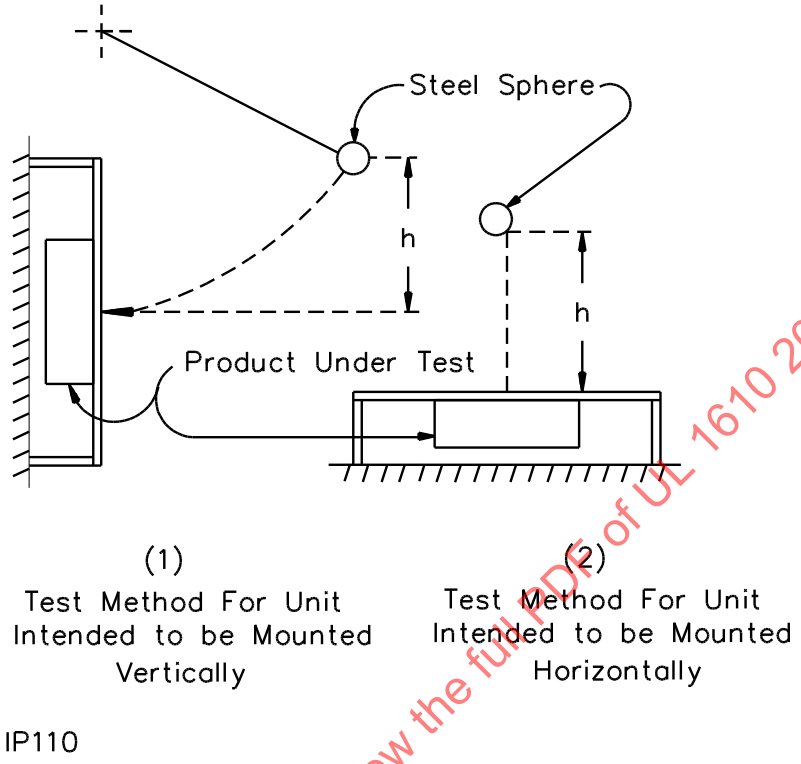
40 Jarring Test

40.1 A central-station burglar-alarm unit shall withstand jarring resulting from impact and vibration anticipated in the intended application without causing operation of any part and without causing operation of any part and without impairing its subsequent intended operation, as evidenced by compliance with the requirements in the Normal Operation Test, Section 27.

40.2 The product and associated equipment is to be mounted as intended to the center of a 6 by 4 foot (1.83 by 1.22 m), nominal 3/4 inch (19.1 mm) thick plywood board that is secured in place at four corners. An impact is to be applied to the center of the reverse side of this board by means of a 1.18 pound-mass (0.54 kg), 2 inch (50.8 mm) diameter steel sphere either swung through a pendulum arc from a height (h) of 30.5 inches (775 mm), or dropped from the height (h) of 30.5 inches, depending upon the mounting of the equipment. See Figure 40.1.

Figure 40.1

Jarring test



ULNORM.COM Click to view the full PDF of UL 1610 2021

40.3 During this test, the unit is to be operated in the normal standby condition and connected to a rated source of supply in accordance with the requirements in 26.3.1.

41 Dielectric Voltage-Withstand Test

41.1 A product 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 41.2):

a) 500 volts (707 volts, if a DC potential is used), for a product rated 30 volts AC rms (42.4 volts DC or AC peak) or less; or

b) 1000 volts (1414 volts, if a DC potential is used), for a product rated between 31 and 250 volts AC rms; or

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

41.2 For the application of a potential between live parts of circuits operating at different potentials or frequencies, the voltage is to be the applicable value specified in 41.1 (a), (b), or (c), based on the highest voltage of the circuits under test instead of the rated voltage of the product. Electrical connections between the circuits are to be disconnected before the test potential is applied.

41.3 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an AC test potential in accordance with 41.1(c) is to be applied directly to all wiring involving more than 250 volts.

41.4 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 maintaining the specified AC test potential, the capacitor or filter is to be tested using a DC test potential in accordance with 41.1.

41.5 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.

41.6 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 dielectric voltage-withstand tests are made. A representative subassembly may be tested instead of an entire 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.

42 Temperature Test

42.1 The materials used in the construction of a central-station burglar-alarm unit shall not attain temperature rises greater than those indicated in Table 42.1.

Table 42.1
Maximum temperature rises

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
A. COMPONENTS				
1. Capacitors:[a,b]				
a. Electrolytic types	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				
(i) Maximum 60 percent of rated volts	50	(90)	75	(135)
(ii) 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)

Table 42.1 Continued on Next Page

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 42.1 Continued

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
c. Class 155 insulation system:				
(i) Class 2 transformers:				
Thermocouple method	95	(171)	95	(171)
Resistance method	115	(207)	115	(207)
(ii) Power transformers:				
Thermocouple method	110	(198)	110	(198)
Resistance method	115	(207)	115	(207)
d. Class 180 insulation system:				
(i) Class 2 transformers:				
Thermocouple method	115	(207)	115	(207)
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 footnote 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 limit of the material			
d. Phenolic composition used as electrical insulation or as parts whose malfunction or deterioration may result in a risk of electric shock, explosion, fire, or injury to persons[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 of the compound			
g. Fuses	25	(45)	65	(117)
B. CONDUCTORS				
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 normally 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):				

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Table 42.1 Continued on Next Page

Table 42.1 Continued

Materials and components	Normal standby, °C	Normal standby, (°F)	(Signaling) alarm condition, °C	(Signaling) alarm condition, (°F)
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 shall not be more than 65°C (117°F).

[b] A capacitor which operates at a temperature higher than a 65°C (117°F) rise may be evaluated 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 an inspection stress test followed by operation 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 an Operational Test.

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

[f] For standard insulated conductors other than those mentioned, reference should be made to the National Electrical Code, ANSI/NFPA 70, the maximum allowable temperature rise in any case is 25°C (45°F) less than the temperature limit of the wire in question.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

42.2 The temperature values in Table 42.1 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 at not less than 5-minute intervals, indicate no change.

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

42.4 Thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type indicating instrument shall be used whenever referee temperature measurements by thermocouples are necessary.

42.5 The temperature of a coil winding may be determined by the change-in-resistance method, wherein resistance of the winding at the temperature to be determined is compared with the resistance at a known temperature, by means of the equation:

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

in which:

Δt is the temperature rise in degrees C;

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

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

k is 234.5 for copper or 225.0 for electrical conductor grade aluminum;

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

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

42.6 To determine compliance with these requirements, the product is to be connected to a supply circuit of rated voltage and frequency in accordance with 26.3.1 and operated continuously under representative service conditions that are likely to produce the highest temperature.

42.7 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 intended current.

42.8 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 normal alarm signaling condition of a unit intended to produce a continuous signal until it is restored to normal.

42.9 If a product has provision for multiple zones, 10 percent of the total number of zones, but not less than three zones, are to be energized during the alarm or other intended operating condition.

43 Abnormal Operation Test

43.1 A central-station burglar-alarm unit operating in any condition of intended operation shall not increase the risk of fire or electric shock when abnormal fault conditions are introduced.

43.2 To determine compliance with the requirement in 43.1, the product is to be connected to a source of supply in accordance with 26.3.1 and operated under the most severe circuit fault conditions likely to be encountered in service. There shall not be emission of flame or molten metal, or any other manifestation of fire; see 43.4. The product shall also comply with the requirements in the Dielectric Voltage-Withstand Test, Section 41.

43.3 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 represent typical fault conditions.

43.4 The product shall be wrapped in a single layer of bleached cheesecloth having an area of 14 – 15 square yards to the pound (26 – 28 m^2/kg) and a count of 32 by 28, and then energized. There shall not be molten metal or flame emitted from the unit as a result of this test as evidenced by ignition or charring of the cheesecloth. The dielectric voltage-withstand test shall be conducted immediately at the conclusion of the test.

44 Electrical Transient Tests

44.1 General

44.1.1 A central-station burglar-alarm 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

ULNORM.COM : Click to view the full PDF of UL 1610 2021

induced transients, and 60 input/output circuit transients while energized from a source of supply in accordance with 26.3.1.

44.2 Supply line transients

44.2.1 A high-voltage AC-operated product, in normal standby condition, shall:

a) Not false alarm;

b) Operate as intended; and

c) Retain required stored memory, such as date, type and location of a signal transmission within the unit

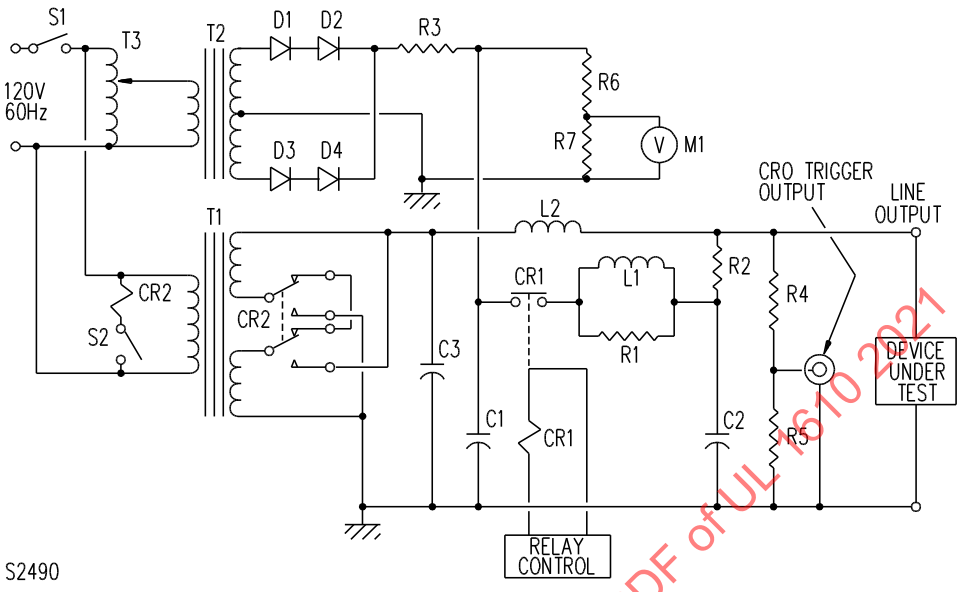
when subjected to supply line transients induced directly onto the power supply circuit conductors of the product under test. Supplemental information stored within the unit need not be retained.

44.2.2 For this test, the product is to be connected to a transient generator, consisting of a 2 kVA isolating power transformer and control equipment that produces the transients described in 44.2.3. See Figure 44.1. The output impedance of the transient generator is to be 50 ohms.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Figure 44.1

Surge generator circuit



C1	– Capacitor, 0.025 µF, 10 kV	R3	– Resistor, 1.3 Megohms, (twelve in series, 110 K ohms each, 1/2 W)
C2	– Capacitor, 0.006 µF, 10 kV	R4	– Resistor, 47K ohms (ten in series, 4.7 K ohms each, 1/2 W)
C3	– Capacitor, 10 µF, 400 V	R5	– Resistor, 470 ohms, 1/2 W
CR1	– Relay, coil 24 V, DC. Contacts, 3-pole, single throw, each contact rated 25 A, 600 V, AC maximum, all three poles wired in series	R6	– Resistor, 200 Megohms, 2 W, 10 kV
CR2	– Relay, coil 120 V, AC. Contacts, DPDT, provides either 120 V or 240 V test circuit.	R7	– Resistor, 0.2 Megohms (two in series, 100 K ohms each, 2 W, carbon)
D1 – D4	– Diodes, 25 kV PIV each	S1	– Switch, SPST
L1	– Inductor 15 µH [33 turns, 22 AWG wire, wound on 0.835 inch (21.2 mm) diameter PVC tubing]	S2	– Switch, SPST, key–operated, 120 V, AC, 1 A
L2	– Inductor, 70 µH [45 turns, 14 AWG wire, wound on 2.375 inch (60.33 mm) diameter PVC tubing]	T1	– Transformer, 2 kVA, 120 V primary, 1:1 (120 V or 240 V output)
M1	– Meter, 0 – 20 V, DC	T2	– Transformer, 90 VA, 120/15,000 V
R1	– Resistor, 22 ohms, 1 W, composition	T3	– Variable autotransformer, 2.5 A
R2	– Resistor, 12 ohms, 1 W, composition		

ULNORM.COM : Click to view the full PDF of UL 1610 2021

44.2.3 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 not more than 60 percent of the value of the preceding peak.

44.2.4 The product is to be subjected to 500 oscillatory transient pulses induced at a rate of 6 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.

44.3 Internally induced transients

44.3.1 The product is to be energized in the intended standby condition while connected to a source of supply in accordance with 26.3.1. The supply source is to be alternately de-energized for approximately 1 second, then energized for approximately 9 seconds, for a total of 500 times. Each interruption is to be at a rate of not more than 6 interruptions per minute. Standby power is to be connected during this test.

44.4 Input/output circuit transients

44.4.1 The product is to be energized in the normal standby condition while connected to a source of supply in accordance with 26.3.1. All input/output circuits are to be tested as specified in 44.4.2.

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

44.4.2 Input/output circuits are to be tested as specified in 44.4.3 – 44.4.5. The signaling equipment connected to these circuits shall:

a) Not false alarm;

b) Operate as intended; and

c) 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 44.4.3. Supplemental information stored within the unit need not be retained.

Exception: Transients applied to the modem or interface module of packet switched data network systems shall not affect the operation of the system except for the modem or interface circuit. Failure of the packet switched data network signaling circuit is acceptable if the loss of communication is annunciated at the receiving station. See 66.2.

44.4.3 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 110 microseconds, and energy levels not less than 0.3 joule or greater than 1.2 joules. The transient pulses are to be coupled directly onto the input/output circuit conductors of the equipment under test.

44.4.4 The equipment is to be subjected to 60 transient pulses induced at a maximum rate of 6 pulses per minute as follows:

ULNORM.COM : Click to view the full PDF of UL 1610 2021

a) 20 pulses (2 at each transient voltage level specified in 44.4.3) between each input/output circuit lead or terminal and earth ground, consisting of 10 pulses of one polarity, and 10 of the opposite polarity (total of 40 pulses) and

b) 20 pulses (2 at each transient voltage level specified in 44.4.3) between any two input/output circuit leads or terminals consisting of 10 pulses of one polarity and 10 pulses of the opposite polarity.

44.4.5 At the conclusion of the test, the equipment shall comply with the requirements in the Normal Operation Test, Section 27.

45 AC Induction Test

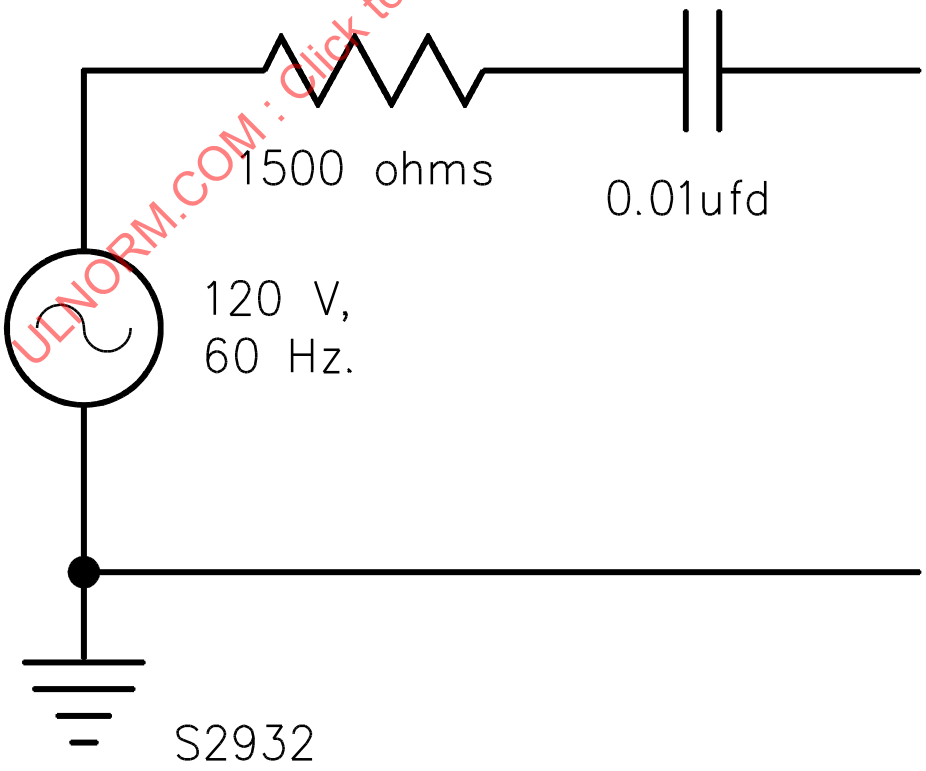
45.1 Central-station burglar-alarm units shall not false alarm and shall operate as intended when subjected to an alternating current induced in any signal leads, initiating device leads, DC power leads, or in any other leads which extend throughout the premises wiring.

Exception: AC power leads and any leads consisting of conductors insulated from and surrounded by a shielding conductive surface grounded at one or more ends are exempted from this test.

45.2 To determine compliance with the requirements in 45.1, the product is to be energized from a source of rated voltage and frequency in accordance with 26.3.1, and a 60-hertz current is to be injected into each circuit extending from the product. The AC signal current shall be induced by the circuit illustrated in Figure 45.1 to simulate induction from AC power sources.

Figure 45.1

AC induction test circuit



ULNORM.COM : Click to view the full PDF of UL 1610 2021

46 Polymeric Materials Test

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

47 Battery Replacement Test

47.1 The battery connections of a central-station burglar-alarm unit shall withstand removal and replacement from the battery terminals without appreciable reduction in contact integrity. Batteries used for principal power shall be subjected to 50 cycles, and standby batteries to 10 cycles, of removal and replacement.

47.2 For this test, a product is to be installed as intended in service and the battery connections removed and replaced as recommended by the manufacturer. The product then shall comply with the requirements in the Normal Operation Test, Section 27.

48 Drop Test

48.1 As a result of the product being dropped onto a hardwood floor, as described in 48.2:

a) The electrical spacings within a portable cord-connected high-voltage product shall not be reduced below the limits specified in Spacings, General, Section 24, and Spacings, Components, Section 25;

b) No high-voltage live parts shall be exposed; and

c) No risk of fire after product energization as described in 48.3.

See 7.2.4 and 7.2.5.

48.2 A sample of a portable cord-connected high-voltage product is to be dropped four times from a height of 3 feet (0.91 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 are to be in place for this test.

48.3 Following the test described in 48.2, the product then is to be wrapped in a single layer of bleached cheesecloth having an area 14 – 15 square yards to the pound (26 – 28 m^2/kg) and having a count of 32 by 28, and energized for 3 hours at rated voltage in accordance with 26.3.1. 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 41.

49 Strain Relief Test

49.1 Supply cord

49.1.1 When tested as described in 49.1.2, strain relief means provided on the flexible cord shall withstand for 1 minute without displacement, a pull of 35 pounds-force (156 N) applied to the cord. During this test the connections within the product are to be disconnected.

49.1.2 A 35-pounds-mass (15.88-kg) weight is to be secured to the cord and supported by the product so that the strain relief means will be stressed from any angle that the construction of the product permits.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

There shall be no movement of the cord sufficient to indicate that stress would have been transmitted to the internal connections.

49.2 Field-wiring leads

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

50 Ignition Through Bottom-Panel Opening Tests

50.1 General

50.1.2 Both of the bottom-panel constructions described in 9.1.4 may be used without test. Other constructions may be used if they comply with the requirements specified in 50.2.1 – 50.3.3.

50.1.3 These tests do 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. See the Abnormal Operation Test, Section 43.

50.2 Hot, flaming oil

50.2.1 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.

50.2.2 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 other area that is well ventilated but free from drafts. One layer of bleached cheesecloth having an area of 14 – 15 square yards to the pound (26 – 28 m^2/kg) and a count of 32 by 28 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 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 center of the pattern of 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.

50.2.3 A small metal ladle [preferably not more than 2-1/2 inches (63.5 mm) in diameter] with a pouring lip and a long handle whose longitudinal axis is to remain 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/l) (see Specification for Fuel Oil, ASTM D396-92). 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 openings 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.

50.2.4 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, the cheesecloth is to be replaced again and a third identical pouring is to be made. The cheesecloth shall not ignite as a result of any of the three pourings.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

50.3 Molten PVC and copper

50.3.1 Openings in a bottom panel shall be so arranged and sufficiently small in size and few in number that molten polyvinyl chloride (PVC) and copper dripping onto the openings from above the panel do not pass through the openings in sufficient quantity to ignite cheesecloth below the openings.

50.3.2 A sample of the complete, finished bottom panel is to be securely supported in a horizontal position 2-1/2 inches (63.5 mm) above a horizontal firebrick or other nonflammable surface located under a hood or in another well ventilated area. Two layers of bleached cheesecloth having an area of 14 – 15 square yards to the pound (26 – 28 m^2/kg) and having a count of 32 by 28 is to be placed on the nonflammable surface. The cheesecloth is to cover somewhat more area than that immediately under the pattern of openings in the panel. Use of a metal screen or wired-glass enclosure surrounding the test area is recommended to reduce the risk of injury to persons and other damage due to splattering of the molten materials.

50.3.3 A bare 12 inch (305 mm) length of 12 AWG (3.3 mm^2) solid copper wire and a 12 inch length of 12 AWG stranded copper wire insulated with 1/32 inch (0.8 mm) of PVC are to be melted simultaneously at an even rate by means of an oxy-acetylene torch and allowed to drop from a point 6 inches (152 mm) above the pattern of openings in the panel.

51 Mechanical Strength Tests for Enclosures

51.1 The external enclosure of a product containing high-voltage circuits or other than power-limited circuits shall withstand a force of 25 pounds-force (111 N) for 1 minute without:

a) Permanent distortion to the extent that spacings are reduced below the values specified in 24.2 – 24.5,

b) Transient distortion that results in the enclosure contacting live parts, and

c) Causing openings which expose uninsulated high- or low-voltage live parts.

The force is to be applied by the curved side of a 1/2-inch (12.7-mm) diameter steel hemisphere. Any openings that occur during application of the force are to be evaluated according to the requirements specified in 7.2.4 and 7.2.5.

51.2 The external enclosure of a product containing only low-voltage power-limited circuits is to be subjected to the test in 51.1, except that the enclosure shall withstand an applied force of 10 pounds (44.5 N).

51.3 The external enclosure of a product containing high-voltage circuits of other than power-limited circuits shall withstand an impact of 5 foot-pounds (6.78 J) without:

a) Permanent distortion to the extent that spacings are reduced below the values specified in 24.2 – 24.5,

b) Transient distortion that results in the enclosure contacting live parts, and

c) Causing openings that expose uninsulated high- or low-voltage live parts.

The impact 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 (1.30 m). Any openings resulting from the impact are to be evaluated according to the requirements in 7.2.4 and 7.2.5.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

51.4 The external enclosure of a product containing only low-voltage power-limited circuits is to be subjected to the test described in 51.3, except that the impact is to be 2 foot-pounds (2.7 J) and the sphere is to fall freely from rest through a vertical distance of 20-13/32 inches (0.52 m).

52 Special Terminal Assemblies Tests

52.1 General

52.1.1 To determine compliance with the requirements in 13.2.3.1 and 13.2.3.2, representative samples of the terminal assembly shall comply with the requirements in 52.2.1 – 52.5.2.

Exception: Terminals complying with the requirements in any of the standards specified in 13.2.1.2 are not required to be subjected to these tests.

52.2 Disconnection and reconnection

52.2.1 If a wire is to be disconnected for testing or routine servicing and then reconnected, each terminal shall be subjected to twenty alternate disconnections and reconnections prior to the tests described in 52.2.2 – 52.5.2.

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

52.2.3 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.

52.3 Flexing test

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

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

52.4 Millivolt drop test

52.4.1 The millivolt drop across a terminal connection using the maximum and minimum wire sizes intended to be used shall not be greater than 300 millivolts with the maximum current specified by the manufacturer flowing through the terminal connections and the circuit connected to rated voltage.

52.4.2 Six terminal assemblies using the maximum wire size and six assemblies using the minimum size shall 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 is to be measured by using a high impedance millivoltmeter.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

52.5 Temperature test

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

52.5.2 Six terminal assemblies using the maximum wire size and six using the minimum size shall 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 series connection of the terminals. The maximum temperature rise is to be measured by the thermocouple method after temperatures have stabilized.

INTRUSION DETECTION DEVICES

53 General

53.1 Intrusion detection portions of a central-station burglar-alarm unit, such as a motion detector, proximity detector, sound detector, vibration detector, or the like, shall comply with the appropriate performance requirements in the Standard for Intrusion-Detection Units, UL 639.

CONTROL UNITS

54 General

54.1 The subscriber control unit shall provide for the connection of protective wiring, conductors, and attachments in accordance with the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681.

54.2 A control unit or terminal panel intended to be located outside of a complete vault, a complete safe, or an extent No. 1 stockroom shall be electrically protected so that an opening cannot be created of sufficient size to permit defeat of the system without resultant initiation of an alarm condition. A tamper device that will initiate an alarm if the unit is removed from its mounting surface is to be considered sufficient for the protection of the mounting surface side of the unit.

54.3 A control unit mounted inside the protected area shall have the cover electrically supervised through the protective wiring circuit to protect against unauthorized opening. See 9.2.3.

54.4 Openings in the enclosure shall not give access to any relays, terminals, controls, or related components that might be subject to tampering by hand or with hand tools, wires, hooks, and the like, without causing an alarm signal.

DIRECT-WIRE SYSTEMS

55 General

55.1 As used in this standard, the term "direct-wire system" refers to a system that provides for the connection of a single protection system to a single alarm receiving unit at the central-station.

55.2 Protection circuit conductors and devices and signaling circuit lines to the central-station shall form one or more supervised circuits arranged so that a signal will be initiated at the central-station if a circuit opens, short-circuits, becomes grounded, or undergoes other significant change of resistance or current flow. See 57.1.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

55.3 The circuit shall be arranged so that an alarm condition produces visual and audible signals of known origin at the central-station. The signals shall continue to indicate until they are recorded and the circuit is restored to nonalarm status by the operator.

55.4 The visual signal shall be individual to each switchboard unit and shall continue as long as the circuit is in an alarm condition.

Exception: This requirement does not apply if the switchboard unit can be connected so that a return to nonalarm condition is indicated by audible and visual means.

55.5 An audible signal may be connected in common to more than one switchboard unit.

55.6 Means shall be provided to silence the audible signal. The silencing of the common audible signal specified in 55.5 shall not disable the audible signal for an alarm from any other protected premises.

56 Alarm Receiving Units

56.1 An alarm receiving unit shall provide a method of determining the line current, or obtaining a reading indicative of circuit condition.

56.2 A milliammeter, galvanometer, or similar instrument that is connected in each alarm receiving unit and that continuously monitors the circuit is the preferred method of complying with the requirement of 56.1. A milliammeter common to each section of alarm receiving units and provided with a flexible cord and plug or switching key so that it may be quickly connected into each line circuit may be used.

56.3 One alarm receiving unit shall be connected to one alarm system.

57 Subscriber Units

57.1 A subscriber's control unit used in a direct-wire system shall transmit a signal to the central-station if resistance or current flow in the protective system deviates more than ±50 percent from the normal protection on value.

57.2 When a subscriber's premises is open and protection is not set, a subscriber's control unit shall transmit a signal to the central-station if a circuit in the permanent (24-hour) protective wiring opens.

57.3 The act of changing the protection mode at the subscriber unit shall cause a signal at the central-station. See 73.1.

TRANSMITTER SYSTEMS

58 General

58.1 As used in this standard, the term "transmitter system" refers to a system that provides for the connection of more than one protection system to a single alarm receiving unit.

58.2 Connection between the subscriber's protective wiring and the central-station circuit shall be affected by means of a code transmitter connected to or integrated with the subscriber's control unit. Under this arrangement, placing the subscriber's control unit in the "set" position shall cause transmission of a closing signal. See 62.9. Any disturbance of the subscriber's protective system during this period when protection is set shall immediately operate the code transmitter, thereby signaling the central-station.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

58.3 The central-station signaling circuit shall be of the closed-circuit (supervised) type. Signals from the transmitters shall open this circuit.

58.4 Circuitry within the central-station and signaling circuitry connecting transmitters to the central-station shall be arranged so that neither a single break nor a single ground in the line can prevent the reception of signals from any transmitter on that circuit.

58.5 The signaling circuitry specified in 58.4 shall be arranged so that a break or a ground in the line causes a signal at the central-station that calls the operator's attention to, and identifies, the nature of the trouble.

58.6 A visual indication to the operator shall be activated whenever the circuit is being operated with a break, ground, or other impairment.

58.7 To check that both lines connecting a transmitter to the central-station have not been severed, either an hourly automatic test signal shall be transmitted from each subscriber's premises during the closed period, or the central-station operator shall, at will, be able to cause each transmitter to send in a test signal.

Exception: Hourly test signals are not required if either:

a) Central-station lines enter the premises in underground cables or

b) These lines enter and leave the premises at separate points at least 10 feet (3.1 m) apart and the subscriber's protective circuit is installed with the central-station line to the nearest junction.

These two methods of installation shall be included in the installation and operating instructions. See Installation and Operating Instructions, Section 4, and Exception No. 1 to 63.3.

58.8 The test signals specified in 58.7 shall provide supervision of both the subscriber's protective circuit and the circuitry connecting the central-station line to the transmitting mechanism.

59 Dual Signal Line Transmission Methods

59.1 Signals shall be transmitted by one or more of the following methods:

a) Direct wire;

b) Multiplex;

c) Derived channel;

d) Two way radio;

e) One way radio;

f) Code transmitter;

g) DACT/DACR;

1) Telephone line,

2) Cellular;

h) Packet switched data networks.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

59.2 A signal transmission method that does not provide an acknowledgment signal shall not be used alone. An additional signal transmission method shall be required to provide an acknowledgment signal.

59.3 When more than one means of signal transmission is used, loss of communication with the receiving system shall be annunciated at the receiver within 200 seconds. If a fault is detected on any of the signal transmission means, at least one of the signal transmission channels shall send a signal to the central-station to report the fault within 200 seconds.

Exception No. 1: If the protection system uses a second method of signal transmission to the central receiving station, the time to annunciate and record the condition may be 6 minutes (360 seconds), if the following conditions are met:

a) A protection system that uses this method of checking for a compromise attempt shall use two methods of signal transmission to the police station or central station. Loss of the second method of signal transmission shall be annunciated at the central station receiver within 200 seconds.

b) An alarm signal is sent to the central receiving station over both methods of signal transmission.

c) The second method of signal transmission need not comply with the multiplex requirements, but shall comply with the requirements of one of the methods of signal transmission of this standard.

d) The following individual faults on the antenna circuit on an RF system that prevents communication to the central station shall be annunciated at the central station receiver within 200 seconds. A fault is defined as:

1) A single open,

2) A single earthground, or

3) A wire-to-wire short.

Exception No. 2: During the disarmed period, the time to annunciate and record the condition may be extended to 60 minutes if Exception No. 1 and the following conditions are met:

a) The method used to detect and report the occurrence of a condition that can prevent the receipt of signals from the protection system and to annunciate that condition shall be applied at a statistically random rate. The minimum time between random checks shall be 5 minutes or less.

b) When armed, the multiplex system shall check that signals can be transmitted to the central station. If the multiplex system cannot send a signal to the central station, a signal to report the condition shall be transmitted to the central station over the second method of signal transmission.

59.4 When more than one method of signal transmission is used in an alarm system that provides standard line security or encryption line security on one or more of the methods, alarm signals shall be transmitted over each method. Opening signals shall be transmitted immediately by either:

a) The method of transmission that provides line security or

b) The method that does not provide line security. If the opening signal is not transmitted within five attempts the opening signal or a failure to communicate signal shall be transmitted over the method that provides line security.

59.5 When more than one method of signal transmission is used in an alarm system that does not provide standard line security or encryption line security, the system shall have the capability to transmit alarm signal over either line.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

59.6 A system which meets the requirement of 59.3 and transmits alarm signal on both lines shall be marked for its function as suitable as a dual signal line transmission system. See 100.2.

59.7 A dual line DACT shall be considered as a dual signal line transmission system if it meets the requirements of 59.3 and 59.5 and provides for a 24–hour check-in signal over one line. One line shall be a switched landline and the other shall be cellular.

59.8 In a dual line transmission system, individual faults on the antenna circuit on an RF system that prevents communication to the central station shall be annunciated at the central station receiver within 200 seconds. A fault is defined as:

a) A single open,

b) A single earthground, or

c) A wire-to-wire short.

60 Single Signal Line Transmission Methods

60.1 Signals shall be transmitted by one or more of the following methods:

a) Multiplex;

b) Derived channel;

c) Two way radio;

d) One way radio;

e) DACT/DACR; [MFVN (See 3.15)];

1) PSTN

f) Cellular;

g) Packet switched data networks [PSDN (See 3.18.)]

60.2 A signal transmission method that does not provide an acknowledgment signal, back to the subscriber's alarm control unit, in response to the receipt of a signal from the protected premises, shall not be used.

60.3 Each supported transmission method will be evaluated according to the appropriate section within this standard, in addition, digital transmission signaling, 60.1 (e) shall comply with the signaling requirements in Section 26 of the Standard for Digital Alarm Communicator System Units, UL 1635, as applicable, with the "single line" method.

60.4 Loss of an incoming line, connected to the receiving system, shall be annunciated at the central-station, within 200 seconds.

60.5 Loss of the outgoing line used by the subscriber's alarm control unit shall be annunciated at the protected premises within 200 seconds.

60.6 To check the end-to-end integrity of the communication lines within the protected premises, up to and including, the lines within the central-station, and the ability of the receiver to process signals, a test signal shall be sent no less than once every 24 hours.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

Exception: In the event any other signal is transmitted to the central-station and acknowledged, a test signal is not required until 24 hours has elapsed.

60.7 In the event, the alarm control unit supports standard line security it shall comply with the applicable requirements in Section 75, Compromise Test.

60.8 In the event, the alarm control unit supports encrypted line security it shall comply with the applicable requirements of Section 75, Compromise Test, and Section 76, Encrypted Line Security Equipment.

60.9 In the event the alarm control unit supports Packet Switched Data Network connections, it shall comply with the applicable requirements of Section 66, Packet Switched Data Networks.

61 Central-Station Units

61.1 Code signals shall be received at the central-station on a tape register or other recording instrument. The recording instrument shall print records either in ink or another medium having equivalent permanence.

61.2 An audible supervisory signal shall sound while a code signal is being received. An audible signal may be connected in common to more than one switchboard unit.

61.3 Each central-station signaling line circuit shall be provided with a visual supervisory signal that is energized while a signal is being received from any equipment on its circuit. The signaling circuit from which the signal is being transmitted shall be identifiable under this arrangement.

61.4 If provision is made to prevent signal clash between transmitters on the same signaling circuit, there shall not be loss of signals from any transmitter on the signaling circuit due to:

a) Two or more simultaneous transmissions or

b) A second transmitter operating before the first has completed its transmission.

62 Subscriber Control Units

62.1 If a subscriber's protective circuit is disturbed, the transmitter shall transmit the code signal to the central-station and shall repeat this code not less than three times.

62.2 A subscriber control unit used in a transmitter system shall transmit an alarm signal to the central-station if the protective circuit is opened, if its conductors of opposite polarity are crossed, or if an initiating device in the circuit transfers to an alarm condition.

62.3 The transmitting mechanism shall be enclosed in an electrically protected enclosure. Protection for the transmitting mechanism shall comply with the requirements in the Attack Tests, Section 74.

62.4 Electrically operated transmitters shall be provided with supervision of both their source of energy and their driving mechanism.

62.5 Spring-wound or mechanically operated transmitters shall be provided with supervision over the wound condition of the mechanism.

62.6 Winding keys projecting outside of the case shall not enable application of torque to stop the mechanism before one complete round of the code signal is transmitted.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

62.7 Means shall be provided whereby the subscriber may test the protection at closing. The results of a positive test shall be indicated by visual or audible means.

62.8 A normal closing signal shall not be transmitted if the protection is not set when the subscriber control unit is placed in the operating mode used for a closed period (protection on).

62.9 An exit signal, distinguishable from an alarm signal, may be used as the closing signal.

COMBINATION SYSTEMS

63 General

63.1 As used in this standard, the term "combination system" refers to a system that provides an alarm sounding device at the subscriber's premises and also uses either a code transmitter, direct-wire unit, multiplex unit, or radio transmitter to transmit signals to the central-station in the event of a either a disturbance of the protective circuit or operation of the alarm sounding device, at the protected premises.

63.2 The protected premise control unit, alarm sounding device and alarm housing shall comply with the requirements in the Standard for Police Station Connected Burglar Alarm Units and Systems, UL 365.

63.3 A combination system shall comply with the appropriate requirements specified in Sections 55 – 62 and 64 – 70 pertaining to the central-station transmission system used.

Exception No. 1: Hourly test signals and the 10-foot (3.1-m) separation of the incoming and outgoing lines connected to the central-station that are specified in 58.7 and 58.8 are not required.

Exception No. 2: A direct-wire or multiplex unit used in transmission of a visual or audible signal from the central-station to the subscriber indicating that the closing signal has been received is not required. See 73.1.

MULTIPLEX SYSTEMS

64 General

64.1 As used in this standard, the term "multiplex system" refers to a system using a method of signaling characterized by the simultaneous or sequential transmission and reception of multiple signals over a single communication channel and provision of means to positively identify each signal. The signaling may be accomplished over a wire path, telephone communication channel, radio carrier, packet switched data networks, or any combination of these. A two-way radio system shall be considered as a multiplex system.

64.2 The signal may be transmitted from the protection system directly to the central-station, or through either a satellite or repeater station.

65 Operation

65.1 Any change in the status of the protection circuit at the protected premises shall be indicated at the central-station by an audible and visible means.

65.2 A change in status shall be automatically recorded. The record shall identify the system, indicate the new status, and include the time and date. A recording device shall consist of either a printer or magnetic medium or other nonvolatile electronic memory capable of being viewed or printed immediately upon request. The year may be manually recorded and need not be shown for each recording.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

65.3 Neither an integral nor a supplementary automatic printout is required if each individual protection system supervised by the multiplex system is provided with an individual display. A change in status shall be indicated automatically by the individual display affected.

65.4 The system shall continue to monitor the other systems while a status change is being recorded.

65.5 A signal that is repeated may be recorded only once, provided that the record indicates the nature of the signal.

65.6 Receipt of the signal shall require acknowledgment by the operator. Acknowledgment shall result in a visible display of the condition of the system.

65.7 If no constant visible display is provided to indicate the condition of each protection system, a means shall be provided by which the operator can determine the condition of any system at any time.

65.8 There shall not be loss or confusion of signals due to temporary outage of central-station equipment or outage of the connecting link between the central-station and the protection systems. The protection system, the satellite station, or the repeater station shall store information concerning any status change occurring during such an outage.

65.9 Indication of a single break, single ground, wire-to-wire short, loss of signal, or any combination of these that can prevent the receipt of signals from the portion of the system affected by the fault shall be automatically recorded. The record shall identify each protective system affected. All changes in the status of the protective systems affected shall be recorded when the fault is cleared.

65.10 In a multiplex alarm system, the time lapse between the occurrence of a status change in a protection system and the annunciation and recording of that change at the central-station shall not exceed 90 seconds. In this time interval, all supervised systems having more than 500 separate signals shall be scanned and the system shall be capable of printing out not less than 50 status changes. Systems having less than 500 separate signals shall be capable of printing out not less than 10 percent of the total separate signals.

65.11 The time lapse between the occurrence of a condition that can prevent the receipt of signals from the protection system and the annunciation and recording of that condition at the central-station shall not exceed 200 seconds. See 65.9.

Exception No. 1: If the protection system uses a second method of signal transmission to the central-station, the time to annunciate and record the condition may be 6 minutes (360 seconds), if the following conditions are met:

a) A protection system that uses this method of checking for a compromise attempt shall use two methods of signal transmission to the police station or central station. Loss of the second method of signal transmission shall be annunciated at the central station receiver within 200 seconds.

b) An alarm signal is sent to the central-station over both methods of signal transmission.

c) The second method of signal transmission need not comply with the multiplex requirements, but shall comply with the requirements of one of the methods of signal transmission of this standard or the Standard for Digital Alarm Communicator System Units, UL 1635.

d) The following faults on the antenna circuit on an RF system that prevents communication to the central station shall be annunciated at the central station receiver within 200 seconds. A fault is defined as:

1) A single open,

ULNORM.COM : Click to view the full PDF of UL 1610 2021

2) A single earthground, or

3) A wire-to-wire short.

Exception No. 2: During the disarmed period, the time to annunciate and record the condition may be extended to 60 minutes if Exception No. 1 and the following conditions are met:

a) The method used to detect and report the occurrence of a condition that can prevent the receipt of signals from the protection system and to annunciate that condition shall be applied at a statistically random rate. The minimum time between random checks shall be 5 minutes or less.

b) When armed, the multiplex system shall check that signals can be transmitted to the central-station. If the multiplex system cannot send a signal to the central-station, a signal to report the condition shall be transmitted to the central-station over the second method of signal transmission.

65.12 A multiplex system shall give priority to signals in the order specified in (a) – (d), and shall annunciate subsequent signals at a rate of not less than one every 10 seconds.

a) The order of priority of signals shall be:

1) Fire alarm.

2) Hold-up or panic alarm.

3) Burglar alarm.

4) Industrial supervision where a danger can result.

5) Watchman tour.

6) Fire-alarm supervision.

7) Burglar-alarm supervision.

8) Industrial supervision where a danger will not result.

9) Other supervisory services.

b) (2) and (3) may have equal priority.

c) (6) and (7) may have equal priority.

d) (8) and (9) may have equal priority.

65.13 If a multiplex system does not annunciate signals in compliance with the order of priority specified in 65.12, signals shall be annunciated by separate means in such a way that the order of priority is maintained.

65.14 A multiplex system that incorporates more than five-hundred initiating device circuits, and does not give priority to signals shall annunciate successive signals at a rate of 1 signal every 1.8 seconds or less (50 signals per 90 seconds). For systems with five-hundred or fewer initiating device circuits, the minimum number of signals annunciated every 90 seconds shall equal 10 percent of the total number of initiating devices in the system.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

66 Packet Switched Data Networks

66.1 Packet switched data network interface equipment, manufactured by other than the burglar alarm equipment manufacturer, that is not required for the processing of the signals shall be evaluated to the applicable requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, either as burglar alarm equipment or communication equipment.

66.2 The connection to the network shall be of an "always on" nature and not require the use of the public switched telephone network to make a "dial up" connection. A loss of an end-to-end connection/signal shall be reported and identified within 200 seconds at the central station receiving unit. Use of cellular communication over the internet is considered a packet switched data network.

Exception No. 1: If the protection system uses a second method of signal transmission to the central-station, the time to annunciate and record the condition may be 6 minutes (360 seconds), if the following conditions are met:

a) A protection system that uses this method of checking for a compromise attempt shall use two methods of signal transmission to the police station or central station. Loss of the second method of signal transmission shall be annunciated at the central station receiver within 6 minutes.

b) If an alarm signal acknowledgement from the central station receiver is not received at the protection system on the first method within 20 seconds, the alarm signal shall be sent to the central station receiver using the second method of signal transmission.

c) The second method of signal transmission need not comply with the multiplex requirements, but shall comply with the requirements of one of the methods of signal transmission of this standard or the Standard for Digital Alarm Communicator System Units, UL 1635.

d) The following individual faults on the antenna circuit on an RF system that prevents communication to the central station shall be annunciated at the central station receiver within 6 minutes. A fault is defined as:

1) A single open,

2) A single earthground, or

3) A wire-to-wire short.

Exception No. 2: During the disarmed period, the time to annunciate and record the condition may be extended to 60 minutes if Exception No. 1 and the following conditions are met:

a) The method used to detect and report the occurrence of a condition that can prevent the receipt of signals from the protection system and to annunciate that condition shall be applied at a statistically random rate. The minimum time between random checks shall be 5 minutes or less.

b) When armed, the multiplex system shall check that signals can be transmitted to the central-station. If the multiplex system cannot send a signal to the central-station, a signal to report the condition shall be transmitted to the central-station over the second method of signal transmission.

66.3 A single open, single earth ground, or wire-to-wire short on the packet switched data networks shall not affect the signaling performance of the premise control unit except for the loss of the function extending from that circuit.

66.4 Supervision signals between premises alarm equipment and supervising station alarm receiver equipment shall be managed by the supervising station receiving equipment and not an intermediary network agent, device or service unless investigated for such service.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

66.5 Neither panel nor receiver software or firmware operating systems shall be susceptible to known security breaches.

66.6 There shall be message authentication between the premise control unit and control receiving equipment.

a) Each message exchanged between the premises and supervising station receiving equipment shall include the network address of the premise equipment, and a hashed (scrambled) key which is changed on every message exchange or

b) A system shall be able to accommodate a minimum of 65,000 distinct account numbers. Message authentication shall consist of an account number plus an additional authentication key which is changed such that a compromise is detected in accordance with Section 75.

66.7 Network addressing of devices shall not make use of public domain name servers.

66.8 Signals between the premise control unit and the receiving equipment, when not carried by wireless means, shall be protected by one of the following methods:

a) The installation instructions shall state that the communication medium between protected property and communications service provider shall be for the exclusive use of the protected property and is not to be shared with other communications service provider subscribers or

b) Each message sent between the premise control unit and the supervising station receiving equipment shall be protected with a cryptographic authentication means.

66.9 When the premises control unit uses a wireless RF link to a device at the point of demarcation for off premises transmission (wireless LAN or WAN) or directly to the receiver, the signals shall be encrypted.

66.10 The display and annunciation requirements for packet switched data network receivers shall comply with the requirements for digital alarm communicator receivers in the Standard for Digital Alarm Communicator System Units, UL 1635 or with the requirements for a multiplex receiver as indicated in this standard.

66.11 If there is no constant visual display provided to indicate each protective system, a means shall be provided by which the operator can determine the condition of any system at any time. A multiplex receiver or a digital alarm communicator receiver with an automation system may be used to determine the status of each system.

66.12 A digital alarm communicator receiver in a packet switched data network does not need to prioritize signals.

66.13 The alarm receiving equipment shall have a recording device of either a printer or magnetic medium or other nonvolatile electronic memory capable of being viewed or printed.

67 Central-Station Units

67.1 The number of signals in each system used for burglar-alarm signals shall be limited to 1000.

Exception: There is no limit to the number of signals if the central-station equipment is completely duplicated by standby equipment and a switchover can be accomplished in not more than 90 seconds without loss of signals during this period.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

67.2 The central-station equipment shall be designed and constructed so that any critical component can be replaced and the system restored to service within 30 minutes.

67.3 With reference to the requirement in 67.2, a critical component is one in which a malfunction will prevent the receipt and interpretation of signals by the central-station operator.

68 Subscriber Control Units

68.1 A subscriber control unit used in a multiplex system shall provide supervision of the protection system, as evidenced by the transmission of alarm signal to the central-station if the protective circuit is opened, if its conductors of opposite polarity are crossed, or if an initiating device in the circuit transfers to the alarm condition.

69 Remotely Accessible Control Units

69.1 General

69.1.1 A remotely accessible control unit is a unit that is able to be accessed with a device other than the unit itself.

69.1.2 When remote access features are provided, the requirements in Section 69 shall apply.

69.1.3 Control units, and the software used in network connected and/or smart environments are within the scope of this standard[a]. The requirements for remote communication, remote operation, and software downloading and installation are given in 69.1 – 69.7 (inclusive). These requirements specifically address the operation of remote controlled control units that are intended to operate security control equipment located within the protected premises that may be physically unattended by the user.

[a] To be referred to as control unit. Generally these include the protected premises control unit and/or it's supporting system platform such as a monitoring station.

69.1.4 Validation of the user, performed by the remote device/connection shall, at a minimum incorporate the security measures as detailed in 69.2.1. See Appendix B, User Validation.

69.1.5 The control unit, when being accessed remotely, shall operate as it would if the accessing were being done from a control unit's human interface located within the protected premises.

69.1.6 The use of remote access shall not compromise the integrity of the control unit being controlled or change the intended use of the control unit.

69.1.7 The manufacturers intended remote access operation shall be defined in the product's installation and operating documentation.

69.1.8 A control unit shall be locally programmed or remotely programmed and securely configured per 69.2 and 69.3 for remote operation before remote access is to be permitted.

69.1.9 Any actions or control activity initiated by the control unit via a direct (trusted physical) path takes precedence and priority over a remotely actuated action.

69.2 Validation of remote access credential

69.2.1 User validation – All remote access communications for the purpose of remote operation to the control unit shall comply with the authentication requirements detailed in this section.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

a) There shall be an assigned “administrator” that has the rights to perform a software/firmware upgrade if this is allowable on the control unit. The administrator shall have priority over commands accessed by remote users.

b) All remote connections shall require defined users. The manufacturer of the control unit shall document any default users (such as factory authorized installers) in the product's installation instructions or manuals. Any special “Undocumented users“ (such as system administrators) defined for debugging or test purposes shall follow the rules of this entire section and shall ensure there is no security risk or unintended use of the control unit with an “Undocumented user“.

c) The control unit shall allow the connection of a user under the following conditions:

1) There can be multiple remote connections per control unit at a time,

2) A timeout feature, after a period of no activity and/or no user connection shall be implemented, if the connection is lost, broken or ended,

3) Access levels that are configured to provide specific functionality on the control unit shall then provide the functionality on the control units that the user is permissioned to execute, and

4) Means shall be provided to detect repeated attempts to gain access not recognized as valid by the control unit. There shall be a mechanism to lockout the system or an individual user from future validation based upon the number of attempts and the time period in which it occurred as specified by the manufacturer.

69.2.2 There shall be a means to validate the identity of the user. This means shall be a user-name and credential that authenticates the validity of the identity of the user. See Appendix B, User Validation. A credential can be a password, PIN, biometric, token, cryptographic mechanism or key.

69.2.3 The validation means shall have a factory default or installation default that comes with the control unit at installation, for example a default PIN or password, with no biometrics or keys as a default.

69.2.4 The validation means shall have a way to reset or return to the factory or installation default.

69.2.5 The user validation means may be a combination of numbers, letters, and symbols. It shall be no less than 4 characters.

69.2.6 The user validation means shall have a way to modify or change the factory default credential during installation and setup.

69.2.7 A user validation mechanism as described in this section shall be used to modify or change any existing or new user validation data and shall be considered a remote operation if performed via a remote connection.

69.2.8 The transmission of the user validation mechanism or credential from a remote device via a remote connection to a control unit covered in this section shall be encrypted.

69.2.9 When provided on the control unit, the storage of the validation mechanism or credential shall not be in plain text and shall be protected from unauthorized disclosure or modification.

69.3 Communication

69.3.1 All remote access connections shall be required to be authenticated and meet the requirements of 69.2.1. See Appendix B, User Validation.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

69.3.2 Any remotely accessible features for maintenance and testing shall either be disabled in a production control unit or shall meet the requirements of this section.

69.3.3 Remote connection from different sources shall not degrade the intended operation of the system at the protected premises and shall not cause any security compromise.

69.3.4 The remote connection to a control unit shall be capable to withstand a compromised attempt by the way of corruption of data, message alteration, spoofing or replay between the sender and the receiver.

69.3.5 Invalid or incorrect data received by the control unit shall not cause the control unit to operate in an unintended way or cause a security compromise.

69.3.6 Session termination (either intended or unintended) shall not have unintended consequences on the control unit or create a security compromise.

69.3.7 Evidence of a certificate of compliance for the validation of approved communication security functions shall be provided. The certificate of compliance shall be from the National Institute of Standards and Technologies (NIST) cryptographic algorithm validation program (CAVP) and shall be a current valid certificate for the security function used by the system and security function. (See 69.4, Communications Data Integrity Standards.)

69.4 Communications data integrity standards

69.4.1 Examples of standardized communications data integrity protection mechanisms are defined in the following:

a) Symmetric Algorithms and techniques

1) NIST SP 800-67, Recommendation for the Triple Data Encryption Algorithm (TDEA) Block Cipher

2) FIPS PUB 197, Advanced Encryption Standard

b) Asymmetric algorithms and techniques

1) FIPS PUB 186-4, Digital Signature Standard (DSS)

c) Message authentication codes and techniques

1) FIPS PUB 198-1, The Keyed-Hash Message Authentication Code (HMAC)

d) Hash functions

1) FIPS 180-4, Secure Hash Standard (SHS)

2) FIPS 198-1, The Keyed-Hash Message Authentication Code (HMAC)

e) Authentication Encryption

1) NIST SP 800-38B, Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication

2) NIST SP 800-38C, Recommendation for Block Cipher Modes of Operation: The CCM Mode for Authentication and Confidentiality

3) NIST SP 800-38D, Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC

ULNORM.COM : Click to view the full PDF of UL 1610 2021

69.5 Software/Firmware upgrade

69.5.1 If the product covered in this standard allows for software or firmware to be modified outside of the manufacturer's facilities, then the product shall comply with this section. These requirements describe the testable criteria for established software/firmware deliverables onto the control unit and its evaluated/compatible system devices.

69.5.2 The software and firmware components described in this section shall include the following:

a) The software or firmware operating system of the product;

b) The application components of the product;

c) Any apps, applications or binary deliverables required to operate the product for its intended use of this standard; and

d) Any apps, applications or binary deliverables required to add non-safety features and functionalities to the product, that are separate from the safety applications.

69.5.3 The software and firmware components of this product shall be clearly documented and traceable by versions.

69.5.4 The software and firmware components of this product shall use a mechanism of configuration management that is defined by the manufacturer. The configuration management mechanism shall maintain a version control and labelling policy to track and record different versions of software/firmware components.

69.5.5 The product shall be able to easily display or demonstrate the version of the currently installed software and firmware components.

69.5.6 The software and firmware components of the product shall be created and delivered such that it protects the previous operable code and all executable code from modification and disclosure from an unauthorized source.

69.5.7 Remote panel programming or configuration access shall require the use of a valid password, the panel's account or network address, and a unique credential to enable a remote programming mode. If an internet connection is used, the data shall be encrypted and an audit trail shall be created in the subscriber control unit and/or the central station and/or the authorized remote programming device.

69.5.8 There shall be an acceptable integrity mechanism, to ensure that software and firmware installed remotely is not corrupted.

69.5.9 Evidence of a certificate of compliance for the validation of approved communication security functions shall be provided. The certificate of compliance shall be from the National Institute of Standards and Technologies (NIST) cryptographic algorithm validation program (CAVP) and shall be a current valid certificate for the security function used by the system and security function. (See 69.6, Data Integrity Standards.)

69.6 Data integrity standards

69.6.1 Examples of standardized data integrity protection mechanisms are defined in the following:

a) Asymmetric algorithms and techniques:

1) FIPS 186-4, Digital Signature Standard

ULNORM.COM : Click to view the full PDF of UL 1610 2021

b) Message authentication codes:

1) FIPS 140-2, Security Requirements for Cryptographic Modules

2) FIPS 185, Escrowed Encryption Standard

c) Hash functions:

1) FIPS 180-4, Secure Hash Standard (SHS)

2) FIPS 198-1, The Keyed-Hash Message Authentication Code (HMAC)

69.7 Software/Firmware deployment process

69.7.1 The new software and firmware components shall be created with an approved software integrity mechanism to generate a factory code or signature for the binary. (See 69.6, Data Integrity Standards.)

69.7.2 Deployment of the software/firmware components to the control unit shall begin with the download of the software/firmware components which can be via a remote connection or direct physical connection.

69.7.3 If upgrade of the software/firmware components to the control unit interrupts the continued operation of the system, it shall be annunciated at the protected premises.

69.7.4 After upgrade of the software component, a software integrity test shall be performed, and meet the following conditions:

a) The integrity test requires the control unit to generate a new integrity value as defined in 69.6 upon successful completion of the upgrade;

b) The integrity test performs a comparison of the factory generated code or signature validated against the integrity value in a.) If the comparison fails, the integrity test fails;

c) If the integrity test fails and the control unit becomes inoperable, it shall be annunciated locally;

d) If the integrity test fails and the control unit can fully recover, it shall revert back to a previous known and functional state;

e) The comparison of the integrity mechanism shall only occur when the control unit has the complete software binary. It shall not be done prior to upgrade; and

f) The factory code or signature shall be included in the software binary and shall not be downloaded separately.

69.8 Event log

69.8.1 If a manufacturer incorporates an event-log, within their control unit, it shall be configured as follows:

a) Loss of power shall have no effect upon the event log;

b) The log shall be remotely accessible;

c) If a remote session is terminated unexpectedly and without proper sign-off, it shall be recorded; and

d) The manufacturer shall specify the period of time in which the log shall be preserved.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

69.8.2 Each event logged shall, at a minimum contain;

a) Date of the event, or equivalent means to determine date;

b) The time of the event, or equivalent means to determine date;

c) An event identifier; and

d) The identification of the user who initiated the event.

70 Automated System Units

70.1 As used in these requirements, an automated system unit refers to central-station equipment that can automatically process routine signals, such as scheduled openings and closings, and record them. A signal requiring an operator's attention, such as an alarm signal, shall be recorded and both visually and audibly annunciated in a manner that identifies the source and type of signal.

70.2 An automated system unit shall be completely duplicated and provision shall be made for switchover in a period of not more than 90 seconds, without loss of signal during this time.

Exception: If an automated system unit serves not more than one thousand active systems and not more than five thousand inactive systems, and uses manual backup equipment, duplication is not required. An active system is a system that transmits a signal to the central-station indicating that the system has been:

a) Opened and the alarm protection removed and

b) Closed and the alarm protection set.

An inactive system is a system that transmits a signal to the central-station only when an unintended condition exists or it is under test. Examples of an inactive system are fire and holdup alarms, and systems supervising protected premises without the use of opening and closing signals.

70.3 An automated system unit using data-processing equipment, office appliances and business equipment shall comply with the:

a) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, and

b) Performance requirements in this standard.

71 Satellite Stations

71.1 A satellite station shall be connected to a manned central-station by two or more supervised channels, of which any can be used to operate the system.

71.2 If all of the channels between a satellite station and a manned central-station are inoperative, any signals received by the satellite station shall be automatically recorded or stored until the satellite station can be manned or the channels restored.

71.3 Signals received at the satellite station during the time that the channels are inoperative shall be transmitted to the central-station when operation is restored.

Exception: Transmission is not required if personnel manning the satellite station have cleared the signals.

71.4 A satellite station shall be equipped so that it can be manned and operated as a central-station.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

72 Private Radio Facilities

72.1 If a private radio carrier is used, the requirements specified in 72.2 – 72.10 shall apply.

72.2 Central, satellite, or repeater stations shall be provided with dual transmitting and receiving equipment.

Exception: Remotely located equipment need not be duplicated unless six or more protection systems are dependent on it.

72.3 Each set of equipment in a dual-equipment installation shall be arranged so that either set can be used for operation of the system.

72.4 Switchover from the operating transmitter to the standby transmitter shall be accomplished in 30 seconds or less. The transfer shall be automatic, or capable of being affected manually by operating personnel.

72.5 Operating personnel shall be able to deactivate either transmitter independently of the other.

72.6 The dual receivers shall be energized at all times and provision shall be made for selection of a usable output from one of the two.

72.7 If the equipment is located in an unmanned area, the circuit extending between the central-station and the equipment shall be supervised to indicate to the operating personnel that a fault has occurred.

72.8 Each transmitter and each receiver shall have its own antenna.

72.9 A visible display at the central-station shall, at all times, indicate the condition of each set. An audio-visual signal shall annunciate any malfunction that would prevent either set from operating.

72.10 The conditions specified in (a) – (d) shall be supervised at the central-station:

a) Transmitter in use (radiating).

b) Impaired operation of AC power supplying either the transmitting or receiving equipment.

c) Receiver malfunction.

d) Automatic switchover.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

ACKNOWLEDGMENT SIGNAL

73 General

73.1 A system shall provide means for the central-station operator to send an acknowledgment signal to the subscriber that a normal closing signal has been received. The premise control unit shall cause an audible or visual indication, or both, when it receives the acknowledgment signal transmitted from the central-station.

73.2 A local alarm sounding device, alarm housing, and control unit shall comply with the mercantile requirements in the Standard for Police Station Connected Burglar Alarm Units and Systems, UL 365.

73.3 A system with standard line security shall comply with the requirements in the Compromise Test, Section 75. A system with encrypted line security shall comply with the requirements of Encrypted Line Security Equipment, Section 76.

74 Attack Tests

74.1 The enclosure protecting a transmitter system's transmitting mechanism in the subscriber's control unit shall resist the attacks specified in 74.6 long enough to permit three rounds of signals to be transmitted before the mechanism can be disabled.

74.2 Each attack is to be continued beyond the time required to transmit three rounds of signals for an additional 60 seconds, or until the transmitter, its circuitry, or its power supply is sufficiently exposed so that if the transmitter were still operating, it could be stopped, and the additional time recorded. The minimum additional time recorded shall establish the maximum entry time delay.

74.3 The transmitter under test is to be securely mounted in its intended position on a board of 3/4-inch (19.1-mm) thick plywood. The board is to extend a minimum of 12 inches (305 mm) beyond each edge of the transmitter. The transmitter and board are to be attached to a substantial rack.

74.4 The tools used in the attack test are to be a tool designed for use on the fastener used to assemble the product, wire cutters, and a blade-type screwdriver not more than 8 inches (203 mm) long from the blade tip to the handle and not more than 1/4 inch (6.4 mm) square or 9/32 inch (7.1 mm) in diameter. The wire cutters are to be restricted to the cutting of conductors inside the enclosure during the attack test. A key or lock pick is not to be used.

74.5 The attack is to be performed by one operator.

74.6 The transmitter is to be subjected to three separate attacks as follows:

a) An attempted disassembly using the tool designed for use on its fasteners,

b) A forcing attack using the blade-type screwdriver, and

c) A combination of disassembly and forcing attack.

74.7 The forcing attack is to be mounted against the enclosure cover, against any slot 1/8 inch (3.2 mm) or more wide, against any other clear opening having a minimum dimension of 1/8 inch or more, and against any knockout not on the mounting surface.

74.8 If more than one opening provided for the passage of conductors through the control-unit enclosure exceeds 3/8 inch (9.5 mm) in any dimension, each of these openings shall be subjected to attack using the screwdriver described in 74.4. If only one such opening is provided, it is not to be tested.

75 Compromise Test

75.1 As referred to in 75.2 – 75.5, a compromise is the disconnection of the protected premises from the connecting line or communication channel in a manner that does not cause a signal at the central-station and, therefore, allows entry into the protected premises without initiating a signal at the central-station. Equipment complying with the requirements in this section shall be classified as either standard line security or encrypted line security. See 73.3.

75.2 The connecting line between the central-station and the protection shall automatically detect a compromise attempt within 6 minutes by any of the methods specified in (a) – (e):

ULNORM.COM : Click to view the full PDF of UL 1610 2021

a) Substitution of electrical resistance.

b) Substitution of an electrical potential.

c) Substitution of randomly selected equipment. Equipment used to make substitutions is to be identical in all aspects to the original equipment. If 95 percent of these substitutions result in detection, the equipment is considered to comply with this requirement.

d) Reintroduction into the system of information transmitted between the central-station and the protected premises. A portable tape recorder is to be used to collect the information from, and then reintroduce the information into, the connecting line or communication channel.

e) Introduction of a synthesized signal into the connecting line or communication channel between the central-station and the protected premises. The signal is to be produced by a portable variable frequency (20 – 20,000 Hertz) signal generator capable of producing sinusoidal, square, and sawtooth waveforms.

Exception: During the disarmed period, the time to detect a compromise may be longer than 6 minutes, but shall not be longer than 60 minutes, if (a) – (d) are all met:

a) The method used to detect and report a compromise attempt shall be applied at a statistically random rate. The minimum time of a random check for a compromise attempt shall be 5 minutes or less.

b) The system shall check for substitution of premises equipment when it is armed. If substitution has occurred the system shall provide an alarm signal to the central-station. The check shall be made by some automatic means, such as an identifying code built into read only memory, rather than relying on some action or acknowledgement by the user that an acknowledgment signal has been received from the central-station, indicating that the central-station has received a normal closing signal.

c) A protection system that uses this method of checking for a compromise attempt shall use two methods of signal transmission to the central-station. Each method of signal transmission shall monitor the other and if either method of signal transmission becomes unable to transmit to the central-station, a signal shall be sent by the other, informing the central-station of the condition.

d) An alarm signal shall be sent to the central-station over both methods of signal transmission. Only one of the transmission methods need comply with the line security requirements, the other shall comply with the requirements of one of the methods of signal transmission of this standard or with the Standard for Digital Alarm Communicator System Units, UL 1635.

75.3 A compromise attempt by one of the methods specified in 75.2 shall cause a locked-in alarm signal that requires attention by central-station personnel.

75.4 An alarm signal caused by a compromise attempt need not be distinguished from a normal alarm signal.

75.5 If a number of systems depend on one signaling line or communication channel, the system against which a compromise attempt is made in accordance with 75.2 shall be identified and the attempt shall not cause confusing signals that appear to originate in one of the other systems on that line or channel.

75.6 The compromise attempts described in 75.2 are to be conducted at the protected premises at the end of the connecting line or communication channel, at terminals or a point located outside of the protected premises.

ULNORM.COM : Click to view the full PDF of UL 1610 2021

75.7 The compromise equipment is to be introduced by a quick-action multiple-pole switch so that the transfer is accomplished in 5 milliseconds or less.

75.8 Voltmeters, ammeters, ohmmeters, and frequency meters, each with an accuracy within 5 percent or less, are to be used to determine the adjustment of the compromise equipment used in 75.2 (a), (b), (d), and (e).

75.9 The amplitude of the compromise signal introduced as described in 75.2 (d) and (e) shall not exceed ±10 percent of the intended signal.

75.10 The deviation of the frequency used for the compromise signal introduced in 75.2 (e) shall not exceed ±10 percent of the intended signal frequency.

76 Encrypted Line Security Equipment

76.1 In addition to the requirements of 75.2 – 75.10, encrypted line security equipment shall use equipment encryption algorithms of a minimum of 128 bits to provide protection against a compromise attempt.

76.2 For products incorporating encrypted line security, evidence of a certificate of compliance for the validation of encryption algorithms [for example, Federal Information Processing Standards (FIPS) 197 or 46-3] or validation of security requirements for cryptographic modules (for example, FIPS 140-2) with the National Institute of Standards and Technology (NIST) shall be provided.

76.3 A compromise attempt against a system provided with encrypted line security equipment shall cause an audible and visual signal within 6 minutes that will require attention by central station personnel. The signal shall be stored after the signal is acknowledged. Equipment complying with the requirements in this section shall be classified as encrypted line security equipment.

POWER SUPPLIES

GENERAL

77 Common Requirements

77.1 These requirements apply to a power supply located at the protected premises and intended to supply energy to the central-station control equipment at the premises. Power supply requirements for equipment at central-station, satellite station, or repeater station are specified in the Standard for Central-Station Alarm Services, UL 827.

77.2 Systems shall not depend solely on commercial power if failure thereof will cause a power failure or render the system inoperative.

77.3 Sources of electrical power that may be used for central-station burglar-alarm protected premises units include rechargeable (secondary) batteries on full float or trickle charge, a power supply with battery standby, and primary batteries.

77.4 A battery provided with the product, other than a primary battery having an open circuit potential of 42.4 volts or less, shall:

a) Be protected by a fuse or circuit breaker rated at not less than 130 nor more than 200 percent of the maximum operating load on the battery or

b) Comply with low-voltage and power-limited requirements as defined in 3.5 (b) and (c).

ULNORM.COM : Click to view the full PDF of UL 1610 2021

77.5 If the product is equipped with terminals for the connection of standby power, the terminals shall be marked with, or reference a drawing that shows, their power ratings including voltage, current, and capacity of batteries in ampere-hours, and the number and type of batteries to be used. See 100.1(d)(2).

RECHARGEABLE (SECONDARY) BATTERIES

78 General

78.1 A rechargeable battery shall have sealed cells with spray-trap vents and shall be floated or trickle charged.

78.2 Batteries 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 battery enclosure as a result of shifting of the batteries. The mounting arrangement shall permit ready access to the cells, if such access is required to check the specific gravity of the electrolyte.

78.3 A conditioning charge shall be limited so that, at the maximum obtainable rate of charge, the battery gases will not affect any part of the control unit.

78.4 The interior of metal cabinets used to enclose vented rechargeable batteries shall be painted with two coats of acid-resistant and alkali-resistant compound, or shall be protected by baked enamel.

78.5 Cabinets used to enclose liquid electrolyte batteries shall be constructed so that the condition of the elements may be observed without disturbing the cells.

78.6 If the battery is contained in a compartment in the same cabinet that houses instruments, the cells shall be located below the instrument compartment or otherwise arranged to reduce the risk of damage to the instruments as a result of leakage or fumes from the battery.

78.7 The central-station burglar-alarm unit manufacturer shall:

a) Provide all specifications, information, and calculations necessary to determine that the battery is used within its specifications and

b) Confirm that the charging method used complies with the battery manufacturer's specifications and continues to provide a charging current under all conditions of intended use.

The conditions of intended use shall include over and undervoltage conditions as described under the Undervoltage Operation Test, Section 32, and the Overvoltage Operation Test, Section 33, in all combinations with the temperature variations described under the Variable Ambient Test, Section 34.

78.8 All conditions of battery discharge shall comply with the battery manufacturer's specifications, with regard to rate of discharge and with automatic voltage cutoff, if required to prevent polarity reversal or damage.

78.9 If two or more cells are used in series or parallel, the conditions of use shall provide for equalization of cells in compliance with the battery manufacturer's specifications.

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

78.11 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.

ULNORM.COM : Click to view the full PDF of UL 1610 2021