

UL 943

ISBN 1-55989-465-2

Ground-Fault Circuit- Interrupters

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Ground-Fault Circuit-Interrupters, UL 943

Third Edition, Dated August 27, 1993

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
1	April 15, 2002
2-3	September 18, 2000
4-5	April 15, 2002
6-8A	September 18, 2000
8B	May 13, 1998
9	August 27, 1993
10	December 16, 1994
11-14	August 27, 1993
15-16	March 24, 1997
16A	September 18, 2000
16B	May 13, 1998
17	January 4, 1995
18	September 18, 2000
19	August 27, 1993
20	May 13, 1998
21-24	September 18, 2000
25-26B	May 13, 1998
27	September 18, 2000
28	August 27, 1993
29	September 18, 2000
30	May 13, 1998
30A	September 18, 2000
30B	May 13, 1998
31	September 3, 1996
32	January 4, 1995
33-34	August 27, 1993
35	April 2, 1996
36	August 27, 1993
37	April 15, 2002
38-52A	September 18, 2000
52B	April 15, 2002
53-58	September 18, 2000
SA1-SA2	September 18, 2000
A1-A2	May 13, 1998

No Text on This Page

AUGUST 27, 1993
(Title Page Reprinted: April 15, 2002)



1

UL 943

Standard for Ground-Fault Circuit-Interrupters

First Edition – December, 1972
Second Edition – September, 1985

Third Edition

August 27, 1993

This edition of UL 943, including all revisions, is approved as an American National Standard. Approval of UL 943 as an American National Standard is maintained using the continuous maintenance process. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-Melville Standards Department, 1285 Walt Whitman Road, Melville, L.I., NY 11747.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Approved as ANSI/UL 943-2002, March 12, 2002

The Department of Defense (DoD) has adopted UL 943 on November 30, 1984. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

ISBN 1-55989-465-2

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No Text on This Page

CONTENTS

FOREWORD	4
----------------	---

INTRODUCTION

1 Scope	5
2 Glossary	5
3 Components	.6A
4 Units of Measurement	.6A
5 References	.6A

CONSTRUCTION

6 General	.6B
7 Resistance to Corrosion	.6B
8 Rainproof Enclosures	.6B
9 Grounding	.9
10 Frame and Enclosure	.9
10.1 General	.9
10.2 Polymeric enclosures	.14
11 Provision for Wiring Systems	.14
12 Connections	.14
13 Accessibility of Energized Parts	.15
14 Internal Wiring	.15
15 Field Wiring	.16
16 Power-Supply Cord	.17
17 Receptacles	.19
18 Spacings	.19
18A Alternate Spacings - Clearances and Creepage Distances	.21
19 Operating Mechanism	.22
20 Supervisory Circuit	.22

PERFORMANCE

21 General	.22
22 Leakage Current Test	.22A
23 Voltage Surge Test	.23
24 High-Resistance Ground Faults Test	.26A
24.1 General	.26A
24.2 High-resistance ground fault test	.27
25 Resistance to False Tripping Test	.31
26 Resistance to Environmental Noise Test	.34
27 Regulation Test	.40
28 Normal Temperature Test	.40
29 Dielectric Voltage-Withstand Test	.41
30 Overload and Motor Starting Test	.42
31 Low-Resistance Ground Fault Test	.43
32 Endurance Test	.45
33 Abnormal Operation Test	.46
34 Extra-Low-Resistance Ground Faults Test	.48
35 Short Circuit Test	.49

36 Chromic Acid Dropping Test	50
37 Dust Test	51
37A Permanence of Marking	52

MARKINGS

38 Details	52
38.1 General	52
38.2 Permanently connected ground-fault circuit-interrupters	52A
38.3 Portable ground-fault circuit-interrupters	52B
39 Installation Instructions	53
39.1 General	53
39.2 Permanently connected ground-fault circuit-interrupters	56

SUPPLEMENT SA - OPTIONAL 10 KA SHORT CIRCUIT CURRENT TEST FOR OUTLET-BOX TYPE GROUND-FAULT CIRCUIT-INTERRUPTERS.

INTRODUCTION

SA1 Scope	SA1
-----------------	-----

PERFORMANCE

SA2 General	SA1
-------------------	-----

MARKINGS

SA3 General	SA2
-------------------	-----

APPENDIX A

Standards for Components.....	A1
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No Text on This Page

FOREWORD

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

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

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

D. A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

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

INTRODUCTION

1 Scope

1.1 These requirements cover ground-fault circuit-interrupters intended for use only in alternating-current circuits wherein one of the wires is grounded in accordance with the National Electrical Code. These devices are intended for use on 120 Vac or 120/240 Vac, 60 Hz circuits.

1.2 These requirements do not cover ground-fault circuit-interrupters intended for use in circuits served by a transformer having windings wholly insulated from each other.

1.3 A ground-fault circuit-interrupter as covered by these requirements is a device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

1.4 *Deleted April 15, 2002*

2 Glossary

2.1 ACCESSIBLE PART – A part so located that it can be contacted by a person, either directly or by means of a probe or tool.

2.2 AUTOMATIC RECLOSURE – Denotes the act of a ground-fault circuit-interrupter resetting itself after having been tripped.

2.3 CLASS A – Denotes a ground-fault circuit-interrupter that will trip when a fault current to ground is 6 mA or more.

2.4 CLASS B – Denotes a ground-fault circuit-interrupter that will trip when a fault current to ground is 20 mA or more.

2.5 CORD-CONNECTED – Denotes connection to a supply circuit by way of a flexible cord terminating in an attachment plug.

2.6 DOUBLE INSULATION – The insulation system resulting from a combination of functional and supplementary insulation.

2.7 ENERGIZED PART – A part at some potential with respect to another part, or to earth.

2.8 FUNCTIONAL INSULATION – The insulation necessary for the proper functioning of the device, and for basic protection against electrical shock hazard.

2.9 GROUND FAULT – Denotes an unintentional electrical path between a part operating normally at some potential to ground, and ground.

2.10 LEAKAGE CURRENT – Denotes all currents including capacitively coupled currents which may be conveyed between energized parts of a circuit and (1) ground or (2) other parts.

2.10.1 OUTLET-BOX TYPE GROUND-FAULT CIRCUIT-INTERRUPTER – A permanently connected ground-fault circuit-interrupter provided with a mounting yoke for mounting in an outlet box; may or may not be provided with receptacle outlets. May be referred to as a receptacle-type GFCI.

2.10.1 added March 24, 1997

2.11 PERMANENTLY CONNECTED – Denotes connection to a supply circuit by way of fixed electrical conductors.

2.12 PORTABLE GROUND-FAULT CIRCUIT-INTERRUPTER – A plug-in type ground-fault circuit-interrupter provided with male blades for connection to a receptacle, or one that is cord-connected. (See 2.5).

2.13 RAINPROOF – Denotes a ground-fault circuit-interrupter so constructed as to prevent rain from interfering with its successful operation.

2.14 RATED CURRENT – The marked value of current.

2.15 RATED VOLTAGE – For devices with a marked voltage within the range of 110– 125 V, the rated voltage is to be considered to be 120 V. For devices with an additional marked voltage within the range of 190 – 250 V, the rated voltage is considered to be 120/240 V.

2.16 REINFORCED INSULATION – An insulation providing protection against electrical shock hazard that is equivalent to double insulation.

2.17 ROOM TEMPERATURE – Air at $25.0 \pm 5.0^{\circ}\text{C}$ ($77.0 \pm 9.0^{\circ}\text{F}$).

2.18 SHOCK HAZARD – A shock hazard is considered to exist at a part of a ground-fault circuit-interrupter if:

- a) There would be current of 6 mA or more in a resistance of 500 ohms connected between the part in question and the grounded supply conductor, and
- b) The device would not operate to open the circuit to the 500-ohm resistor within the time allowed in 24.1.1

2.19 SUPPLEMENTARY INSULATION – An independent insulation provided in addition to the functional insulation to insure protection against electric shock hazard in the event that functional insulation should fail.

2.20 TRIP – Denotes automatic interruption by the ground-fault circuit-interrupter of the electric circuit to the load.

3 Components

3.1 Except as indicated in 3.2, 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.

3.1 revised September 18, 2000

3.2 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.

3.2 revised September 18, 2000

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

3.3 revised September 18, 2000

3.4 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.

3.4 revised September 18, 2000

4 Units of Measurement

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

4.1 revised September 18, 2000

5 References

5.1 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.

CONSTRUCTION

6 General

6.1 The design, workmanship, and degree of production uniformity shall be such that the reliability of the ground-fault circuit-interrupter to perform the functions evaluated by the requirements will be high.

6.2 A ground-fault circuit-interrupter intended to serve also as a junction box for swimming-pool equipment shall comply with the applicable requirements covering swimming-pool junction boxes, UL 1241.

6.3 Male and female contact devices such as plugs, connectors, current taps, and receptacles provided with, or as an integral part of, a ground-fault circuit-interrupter shall also comply with the applicable construction and performance requirements from the Standard for Attachment Plugs and Receptacles, UL 498.

Added 6.3 effective July 4, 1998

7 Resistance to Corrosion

7.1 Parts shall be protected against corrosion if failure of such parts would be likely to result in a hazardous condition, including failure to perform with high-resistance ground faults as provided in these requirements.

8 Rainproof Enclosures

8.1 A rainproof enclosure shall be so constructed as to exclude a beating rain. The enclosure shall be provided with external means for mounting, except that internal means for mounting may be employed if so designed as to prevent water from entering the enclosure. Metals shall not be used in combination such as to cause galvanic action which will affect adversely any part of the device.

8.2 A rainproof ground-fault circuit-interrupter is to be attached to a vertical clapboard surface as in actual service. If there is provision for conduit connection at points above the lowest insulation or live part of the ground-fault circuit-interrupter, an unspecified length of conduit is to be attached with the torque specified in 11.4. The unattached end of the conduit is to be covered to prevent entry of water during this test. A water spray is to be applied from three nozzles so located as to direct the spray against all surfaces that would be exposed to a beating rain. The device is considered to comply with the provisions of 8.1 if there is no entry of water above the lowest insulation or live part of the ground-fault circuit-interrupter.

8.3 An elastomeric material, employed to obtain compliance with the provisions of 8.1 shall be adequately resistant to deterioration.

8.4 In order to determine compliance with the provisions of 8.3, a gasket of rubber or neoprene or a composition thereof is to be exposed for 96 hours to oxygen at a gauge pressure of 300 ± 10 psi (2.07 ± 0.07 MN/m²) gauge and a temperature of $70.0 \pm 1.0^\circ\text{C}$ ($158.0 \pm 1.8^\circ\text{F}$). There is to be no visible evidence of deterioration, or change in hardness of more than 5 numbers (0.0005 inch or 0.013 mm).

8.4 revised December 16, 1994

8.5 Except for threaded holes, there shall not be provision for conduit located above any live part or insulation of the ground-fault circuit-interrupter.

8.6 There shall be provision for drainage of the enclosure, provided that holes for this purpose are to be no larger than 1/4 by 1/4 inch (6.4 by 6.4 mm).

8.7 A rainproof enclosure made of sheet steel having a thickness of 0.120 inch (3.05 mm) or more shall be protected against corrosion by one of the following coatings:

a) Hot dipped mill galvanized sheet steel conforming with the coating designation G60 or A60 in Table 1 of the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Specification. The weight of zinc coating may be determined by any acceptable method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM A90-81(1991). An A60 (alloyed) coating shall also comply with 8.10.

b) A zinc coating, other than that provided on hot dipped mill galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.010 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the Chromic Acid Dropping Test, Section 36. An annealed coating shall also comply with 8.10.

c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The suitability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary.

8.7 revised April 2, 1996

8.8 A rainproof enclosure made of sheet steel having a thickness of less than 0.120 inch (3.05 mm) shall be protected against corrosion by one of the following coatings:

a) Hot dipped mill galvanized sheet steel conforming with the coating Designation G90 in Table 1 of the Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M-94, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM Specification. The weight of zinc coating may be determined by any suitable method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM A90-81(1991).

b) A zinc coating, other than that provided on hot dipped mill galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.015 mm) on each surface with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of the coating shall be established by the Chromic Acid Dropping Test, Section 36. An annealed coating shall also comply with 8.10.

c) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of coating shall be established by the Chromic Acid Dropping Test, Section 36.

d) A zinc coating conforming with item a) or b) of 8.7 with one coat of outdoor paint as specified in item c of 8.7.

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established by the Chromic Acid Dropping Test, Section 36 and the paint shall be as specified in item c of 8.7.

8.8 revised April 2, 1996

8.9 With reference to 8.7 and 8.8, other finishes, including paints, special metallic finishes and combinations of the two may be accepted when comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with item a of 8.7 or 8.8, as applicable, indicate they provide equivalent protection. Among the factors which are taken into consideration when judging the suitability of such coating systems are exposure to salt spray, moist carbon dioxide sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light and water.

8.10 A hot dipped mill-galvanized A60 (alloyed) coating or an annealed coating on sheet steel which is bent or similarly formed or extruded or rolled at edge of holes after annealing shall additionally be painted in the bent or formed area if the bending or forming process damages the zinc coating.

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8.11 If flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered damaged. Simple sheared or cut edges and punched holes are not considered to be formed.

9 Grounding

9.1 All accessible parts of a permanently connected ground-fault circuit-interrupter that are likely to become energized if there should be arc-over, insulation failure, or the like, shall be connected together and to the terminals intended for the equipment grounding conductor (see 15.1). The resistance of the circuit is not to exceed 0.1 ohm, and the circuit shall be capable of withstanding continuously a current of 25 A.

9.2 In considering the provisions of 9.1, a grounded or insulating barrier may be employed to reduce the likelihood that accessible parts will become energized.

9.3 If provided, the equipment grounding conductor of a portable or cord-connected ground-fault circuit-interrupter shall be conductively connected to the grounding contacts of the attachment plug and of the receptacles, and shall not be connected to accessible conductive parts.

10 Frame and Enclosure

10.1 General

10.1.1 A ground-fault circuit-interrupter shall be so formed and assembled that it can withstand the abuses to which it might be subjected without affecting spacings, insulation, accessibility of live parts, performance with high-resistance ground faults, or grounding, to the extent that the device would fail to comply with these requirements.

10.1.2 Opening or removal of a door or cover, with or without the use of a separate tool, that must be opened or removed in order to properly use or install a ground-fault circuit-interrupter shall not increase the likelihood of accidental injury to any part depended upon for the proper functioning of the device. The likelihood of such injury will not be considered to have increased if the part in question has not become accessible. See items a and b of 13.2.

10.1.3 Among the factors taken into consideration when the acceptability of enclosure material is being determined, are (1) physical strength, (2) resistance to moisture absorption, (3) combustibility, (4) resistance to corrosion, and (5) resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use. For a nonmetallic enclosure, all of these factors are considered with respect to thermal aging.

10.1.4 An enclosure of sheet metal having the construction indicated in Table 10.1 or 10.2 will generally be considered to have an acceptable level of the factors shown in 10.1.3.

10.1.5 In determining compliance with the provisions of 10.1.1, a permanently connected ground-fault circuit-interrupter is to be subjected to an externally applied impact of 5 ft-lbs (6.8 J) applied by way of a solid, smooth, steel sphere 2 inches (50.8 mm) in diameter.

Exception: Receptacle-type ground-fault circuit-interrupters are to be subjected to a 3-ft (0.91 m) drop test onto a concrete floor. The method of doing the test shall be in accordance with the provisions of 10.1.8.

10.1.6 The sphere mentioned in 10.1.5 is to be allowed to fall freely from rest through the distance required to cause the specified impact upon the surface under test. For surfaces other than horizontal, the sphere may be suspended by a cord and allowed to fall as a pendulum through the required distance. The ground-fault circuit-interrupter is to be placed against a vertical wall with the surface to be tested in the same vertical plane as the point of support of the pendulum.

Table 10.1
Thickness of sheet metal for enclosures – carbon steel or stainless steel^a

Table 10.1 revised December 16, 1994

Without supporting frame ^b		With supporting frame or equivalent reinforcing ^b		Minimum thickness inches (mm)	
Maximum width ^c Inches (cm)	Maximum length ^d Inches (cm)	Maximum width ^c Inches (cm)	Maximum length ^d Inches (cm)	Uncoated	Metal coated
4.0 (10.2)	Not limited	6.25 (15.9)	Not limited	0.020 ^{e,f} (0.51)	0.023 ^{e,f} (0.58)
4.75 (12.1)	5.75 (14.6)	6.75 (17.1)	8.25 (21.0)		
6.0 (15.2)	Not limited	9.5 (24.1)	Not limited	0.026 ^{e,f} (0.66)	0.029 ^{e,f} (0.74)
7.0 (17.8)	8.75 (22.2)	10.0 (25.4)	12.5 (31.8)		
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)		
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)		
18.0 (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)		
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)		
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)		
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)		
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)		
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)		
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)		

^a Tables 10.1 and 10.2 are based upon the initial deflection of an enclosure surface with a concentrated load at the center of the surface.

^b A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and 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 that 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.

^c 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.

^d For panels which are supported along one side (for example, side panels of boxes) the length of the unsupported side shall be limited to the dimensions specified.

^e Sheet steel for a rainproof enclosure is to be not less than 0.034 inch thick if zinc-coated and not less than 0.032 inch thick if uncoated.

^f Sheet steel is to be not less than 0.032 inch thick if uncoated and not less than 0.034 inch thick if zinc-coated at points to which a wiring system is to be attached.

Table 10.2
Thickness of sheet metal for enclosures – aluminum, copper, or brass^a

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

a–d See notes a–d to Table 10.1.
e Sheet copper, brass, or aluminum for a raintight enclosure is to be not less than 0.029 inch in thickness.
f Nonferrous metal is to be not less than 0.045 inch thick at points to which a wiring system is to be attached.

10.1.7 The surfaces mentioned in 10.1.6 are those exposed during normal service, including operating handles, pushbuttons, and the like. Doors that are hinged or sliding or otherwise captive, and covers that cannot be removed without tools, are to be closed. Other doors or covers are to be opened or removed. A sample that has been struck is not required to withstand another blow. However, if more than one blow is applied to a single sample, a failure after the first blow is to be disregarded provided that the same surface withstands a blow on another sample. If a device fails during the first test, the device is considered to have failed.

10.1.8 A cord-connected or portable device is to be allowed to fall from a height of three feet such that a different part will strike a hardwood surface in each of three drops. Doors or covers are to be moved to any position likely in normal service providing that a captive door or cover is not forced to remain in any position by some means not part of the ground-fault circuit-interrupter.

10.1.9 The hardwood surface mentioned in 10.1.8 is to consist of a layer of nominal 1-inch tongue-and-groove oak flooring mounted on two layers of 3/4-inch (19 mm) plywood. The surface is to be a square 4 ft (1.2 m) on a side. The assembly is to rest on a concrete floor or the equivalent.

10.1.10 The maximum acceptable moment, center of gravity, dimensions, and weight of a direct plug-in unit shall comply with the requirements specified in Items a, b, c and d. See Figure 10.1 and 10.1.11 and 10.1.12.

- a) The quotient of WY/Z shall not exceed 48 ounces (1361 g).
- b) The quotient of WY/S shall not exceed 48 ounces (1361 g).
- c) The product of WX shall not exceed 80 ounce-inches (0.56 N·m).
- d) The weight of a unit shall not exceed 28 ounces (794 g).

10.1.11 Definitions for the symbols used in 10.1.10 are as follows:

W is the weight of the unit in ounces (g).

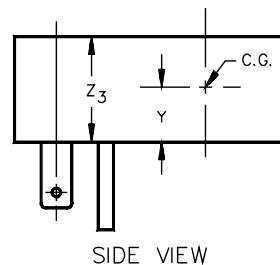
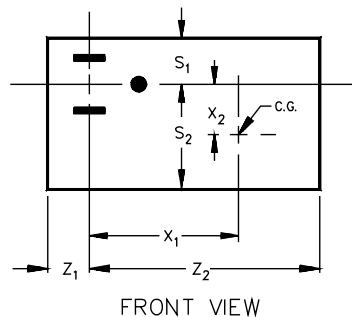
Y is the distance illustrated in Figure 10.1 in inches (mm).

Z is the lesser of the two distances, Z_1 or Z_2 , as illustrated in Figure 10.1, in inches (mm).

S is the lesser of the two distances, S_1 or S_2 , as illustrated in Figure 10.1, in inches (mm).

X is the greater of the two distances X_1 or X_2 , as illustrated in Figure 10.1, in inches (mm).

Figure 10.1
Dimensions of a direct plug-in unit



C.G. = Center of Gravity

CP100

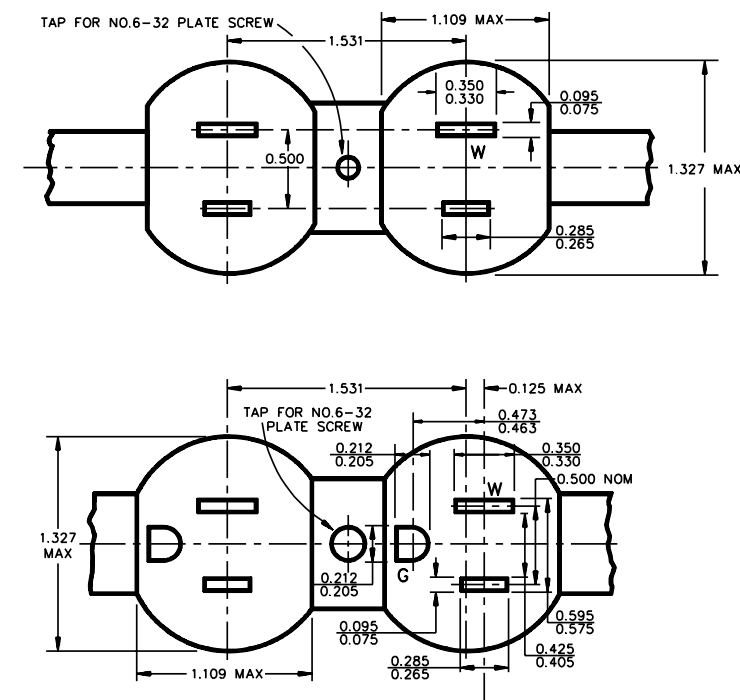
10.1.12 The moment and weight specified in 10.1.10 are to be determined as follows:

- a) For units with an output cord, the cord is to be cut off at the enclosure, or at the strain relief means if the strain relief means is outside the enclosure.
- b) For units with integrally mounted accessories or optional components, the values are to be measured with the accessories or components in place.

10.1.13 When inserted in a parallel-bladed duplex receptacle, any part of a unit, including output wiring, shall not interfere with full insertion of an attachment plug into the adjacent receptacle. See Figure 10.2.

Exception: A unit that renders the adjacent receptacle completely unusable in any one mounting position is acceptable.

Figure 10.2
Parallel duplex receptacle



S3076

10.2 Polymeric enclosures

10.2.1 A polymeric enclosure, or a polymeric part of an enclosure, shall comply with the applicable requirements for enclosures as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: For a direct plug-in ground-fault circuit-interrupter, the crushing test shall be conducted in accordance with 71 of the Standard for Attachment Plugs and Receptacles, UL 498.

10.2.2 An adhesive used in the assembly of a ground-fault circuit-interrupter shall comply with the applicable requirements for adhesives as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: Methods utilizing fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding need not be investigated.

11 Provision for Wiring Systems

11.1 There shall be provision at a permanently connected ground-fault circuit-interrupter for attachment of raceway or cable in accordance with the National Electrical Code, ANSI/NFPA 70.

11.2 A knockout in a sheet-metal enclosure shall be secure but shall be capable of being removed without significant deformation of the enclosure, or dislocating larger sizes of a multiple knockout. A knockout likely to be used during installation shall be surrounded by a flat surface for effective seating of a conduit bushing and shall be so located that installation of a bushing will not result in spacings smaller than those allowed in these requirements.

11.3 A hole tapped for the attachment of threaded rigid conduit shall be so constructed as to permit:

- a) The attachment of a conduit bushing, or there is to be a smooth, well-rounded passage for wires equivalent to that presented by a bushing, and
- b) For raintight equipment, the application of tightening torque as specified in 11.4.

11.4 The torque mentioned in 8.2 and 11.3 is to be applied to the conduit in such a manner as to prevent the application of a bending movement to the assembly. The value of torque is to be 800 lbf-in (90 N·m) for 3/4-inch (19-mm) and smaller trade sizes of conduit, 1000 lbf-in (113 N·m) for sizes larger than 3/4 inch (19 mm) up to 1-1/2 inches (38 mm), and 1600 lbf-in (181 N·m) for sizes larger than 1-1/2 inches (38 mm).

12 Connections

12.1 Except as described in 12.2 and 12.3, a portable cord-connected ground-fault circuit-interrupter provided with an equipment grounding conductor shall have double insulation or reinforced insulation throughout its construction, or if not provided with an equipment grounding conductor shall have double insulation or reinforced insulation on the line side of the device.

12.2 Functional insulation alone is acceptable in a portable or cord-connected device where, in the event that the functional insulation should fail, there would be no shock hazard at the ground-fault circuit-interrupter.

12.3 In performing the evaluation described in 12.2 at a manual switch in the supervisory circuit (described in 20.1), the device need not trip if the value of current available in the event that the functional insulation of the switch should fail would not exceed the value of current employed by the supervisory circuit.

12.4 The equivalent of functional insulation shall be interposed between the grounding conductor of the power-supply cord and accessible parts of a cord-connected ground-fault circuit-interrupter. If such insulation is inherent in a receptacle:

- a) There shall be instructions visible when the receptacle is being removed for replacement to replace the receptacle with only an identical replacement, and how to obtain the replacement, and
- b) It shall not be possible to use a standard grounding-type receptacle as a replacement without first performing a drilling or cutting operation.

12.5 The dielectric of a capacitor is not acceptable as supplementary insulation.

12.6 Except where specifically acceptable for the purpose, the jacket of the power-supply cord of the ground-fault circuit-interrupter is not considered to provide insulation. See 16.5.

13 Accessibility of Energized Parts

13.1 Parts of a ground-fault circuit-interrupter shall not be accessible when they are energized.

13.2 In determining compliance with the provisions of 13.1:

- a) Except at a contact of an attachment-plug receptacle, a part is considered to be accessible if it can be touched with a 3/32-inch (2.4 mm) diameter rod.
- b) A permanently connected device is to be mounted as intended.
- c) A door or cover that can be opened or removed without the use of a separate tool is to be open or removed, and
- d) A door or cover that must be opened or removed in order to use a ground-fault circuit-interrupter is to be opened or removed.
- e) Material that is not acceptable as insulation is considered to be conductive.

13.3 Access to the trip mechanism and electronics of a portable ground-fault circuit-interrupter, not intended to be repaired, shall not be attainable with ordinary tools. Access shall be limited by use of tamper-resistant screws, rivets, welding or other equivalent means.

Added 13.3 effective July 4, 1998

14 Internal Wiring

14.1 The gauge and insulation of wires shall withstand the mechanical and electrical stresses of service. Particular consideration should be given to the effect of vibration and user servicing where wire smaller than No. 24 AWG is employed.