



UL 943

STANDARD FOR SAFETY

Ground-Fault Circuit-Interrupters

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

Fifth Edition, Dated May 17, 2016

Summary of Topics

This new edition of the Standard for Safety for Ground-Fault Circuit-Interrupters, ANSI/UL 943, includes the following changes in requirements:

Yellow Load Label Removal - GFCI Receptacles

GFCI Auto Monitoring Function

Instruction Sheet Change for Weather Resistant Receptacles (WR)

Clause 6.30 Auto-Monitoring Tests

The new/revised requirements are substantially in accordance with Proposal(s) on this subject dated January 8, 2016.

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Association of Standardization and Certification
NMX-J-520-ANCE
Third Edition



CSA Group
CSA C22.2 No. 144.1-16
Second Edition



Underwriters Laboratories Inc.
UL 943
Fifth Edition

Ground-Fault Circuit-Interrupters

May 17, 2016



ANSI/UL 943-2016

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This ANSI/UL Standard for Safety consists of the Fifth edition. The most recent designation of ANSI/UL 943 as an American National Standard (ANSI) occurred on May 17, 2016. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

The Department of Defense (DoD) has adopted UL 943 on November 30, 1994. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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 <http://csds.ul.com>.

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Preface

This is the harmonized ANCE, CSA Group, and UL Standard for Ground-Fault Circuit-Interrupters. It is the third edition of NMX-J-520-ANCE, the second edition of CSA C22.2 No. 144.1, and the fifth edition of UL 943. This edition of NMX-J-520-ANCE supersedes the previous edition published on February 1, 2006. This edition of CSA C22.2 No. 144.1 supersedes the previous edition published in February 2006. This edition of UL 943 supersedes the previous edition published on February 1, 2006, and revised on June 29, 2012.

This harmonized Standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the CANENA Technical Harmonization Subcommittee 23E, Ground-Fault Circuit-Interrupters, are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

The present Mexican standard was developed by the CT 23 Accesorios Electricos from the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE, with the collaboration of the ground fault circuit interrupters manufacturers and users.

This Standard was reviewed by the CSA Subcommittee on Ground-Fault Circuit-Interrupters, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee.

This Standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

Level of harmonization

This Standard uses the IEC format but is not based on, nor shall it be considered equivalent to, an IEC Standard. This Standard is published as an identical Standard for ANCE, CSA Group, and UL.

An identical Standard is a Standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. Presentation is word for word except for editorial changes.

Reasons for differences from IEC

This Standard provides requirements for ground-fault circuit-interrupters for use in accordance with the electrical installation codes of Canada, Mexico, and the United States. At present there is no IEC Standard for ground-fault circuit-interrupters for use in accordance with these codes. Therefore, this Standard does not employ any IEC Standard for base requirements.

Interpretations

The interpretation by the standards development organization of an identical or equivalent Standard is based on the literal text to determine compliance with the Standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

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1 Scope

1.1 This Standard applies to Class A, single- and three-phase, ground-fault circuit-interrupters intended for protection of personnel, for use only in grounded neutral systems in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, the Canadian Electrical Code, Part I, and Electrical Installations (Use), NOM-001-SEDE. These devices are intended for use on alternating current (AC) circuits of 120 V, 208Y/120 V, 120/240 V, 127 V, or 220Y/127 V, 60 Hz circuits.

Note: In Canada, the text “intended for protection of personnel” is excluded.

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 This Standard applies to all Class A ground-fault circuit-interrupters. These Class A GFCIs are permitted to be integrated into other devices, in which case, besides complying with this Standard, these devices are to comply with the corresponding applicable Standard for the device in question.

1.4 This Standard includes minimum requirements for the function, construction, performance, and markings of ground-fault circuit-interrupters included in the scope.

1.5 This Standard is intended to cover only Class A GFCI devices.

1.6 This Standard also covers GFCIs of the self contained type that are intended for installation in a counter, such as would be suitable for installation in a kitchen or bathroom counter top.

2 Normative References

2.1 Any normative 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. See Annex A.

2.2 When a reference is made to another code or Standard, the product shall comply with the installation code or Standard of the country or countries in which the product is intended to be used.

2.3 For products intended for use in Canada general requirements are given in CSA Standard C22.2 No. 0, *Definitions and General Requirements – Canadian Electrical Code, Part II*.

3 Definitions

For the purposes of this Standard, the following definitions apply:

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

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

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3.3 CLASS A – Class A, when applied to a ground-fault circuit-interrupter (GFCI), is an interrupter that will interrupt the circuit to the load when the ground-fault current is 6 mA or more but not when the ground-fault current is 4 mA or less.

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

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

3.6 ENCLOSURE – A surrounding case constructed to provide a degree of protection against incidental contact with the enclosed equipment and to provide a degree of protection to the enclosed equipment against specified environmental conditions.

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

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

3.9 GFCI END OF LIFE – When a GFCI is incapable of providing ground fault protection and passing its internal test function it has reached its end of life.

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

3.11 GROUND-FAULT CIRCUIT-INTERRUPTER – In the US and Mexico, a device intended for the protection of personnel that functions to de-energize a circuit or portion of a circuit within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

In Canada, a device whose function is to interrupt, within a predetermined time, the electrical circuit to the load when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

3.12 HOUSING – The integral envelope directly surrounding the circuit components of the ground-fault circuit-interrupter.

3.13 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.

3.14 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.

3.15 PERMANENTLY CONNECTED – Denotes connection to a supply circuit by way of fixed electrical conductors (see cord-connected).

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3.16 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 cord-connected).

3.17 RATED CURRENT – The marked value of current.

3.18 RATED VOLTAGE – Voltage assigned by the manufacturer. See Table 7.2.1 for details and marked voltage.

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

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

3.21 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 6.7.1.1.

3.22 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.

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

4 General

4.1 Components

4.1.1 Except as indicated in 4.1.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Annex A for a list of Standards covering components generally used in the products covered by this Standard and applicable Mexican Standards. A component shall comply with the ANCE, CSA, or UL Standards as appropriate for the country where the product is to be used. When a product is intended for use in more than one country, a component shall comply with the appropriate component Standard for the countries in which it is being used.

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

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

4.1.3 A component shall be used in accordance with its ratings for the intended conditions of use.

4.1.4 Specific components are accepted as being incomplete in construction features, or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as temperatures not exceeding specified limits, and shall be used only under those specified conditions for which they have been investigated.

4.2 Units of measurement

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

5 Construction

5.1 All types

5.1.1 A ground-fault circuit-interrupter which is intended to be connected to a supply circuit having more than one ungrounded conductor shall be so designed that their intended purpose will not be defeated if any of the ungrounded conductors is not energized in the normal way.

5.1.2 An interrupter having an adjustable circuit component, the setting of which affects the clearing time or the sensitivity, shall be constructed so that:

- a) The component is not visible to the user when the interrupter is in normal use or when it is opened for connecting supply circuit and load circuit conductors; and
- b) Any cover or other part which obscures the component from view requires a tool for removal and is so secured or sealed that the removal can be readily detected. The application of a sealing material directly to the component is considered to comply with the intent of Item (b) for sealing.

5.1.3 Except as specified in 5.1.4, 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 in the Standards referenced in Annex A, Ref. No. 1.

5.1.4 For Canada, as an alternate to the Temperature Test in Clause 7.9 of the Standard for General Use Receptacles, Attachment Plugs, and Similar Wiring Devices, C22.2 No. 42, a receptacle type GFCI may be tested as described in Section 6.28 of this Standard.

For Mexico, as an alternate to the Temperature Test in Clause 6.2.5 of the Standard for Wiring Devices – Safety requirements – Specifications and Test Methods, NMX-J-508-ANCE, a receptacle type GFCI may be tested as described in Section 6.28 of this Standard.

For the US, as an alternate to the Temperature Test in Section 111 of the Standard for Attachment Plugs and Receptacles, UL 498, a receptacle type GFCI may be tested as described in Section 6.28 of this Standard.

5.1.5 In Canada, a portable ground-fault circuit-interrupter:

- a) Is required to have a fixed grounding pin,
- b) Of the direct plug-in type, other than one designed solely for use in a locking type receptacle, shall not include a mounting tab which is intended to connect with a screw retaining the cover of a duplex receptacle in place, or any other means for securing the interrupter to a receptacle or its cover.

5.2 Resistance to corrosion

5.2.1 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. To verify compliance with 5.2.1, see the Corrosion test, Clause 6.21.

5.3 Grounding and bonding

5.3.1 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 5.11.1). 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.

5.3.2 In Canada, the grounding and bonding shall comply with the requirements of Annex A, Ref. No. 2, except the screw size shall be permitted to comply with 5.3.3.

5.3.3 For devices rated 15 A or 20 A the minimum screw size is 4.5 mm (No. 8).

5.3.4 In considering the provisions of 5.3.1, a grounded or insulating barrier may be employed to reduce the likelihood that accessible parts will become energized.

5.3.5 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.

5.3.6 A ground-fault circuit-interrupter shall operate normally if there is an open circuit in the grounding conductor.

Note: In Canada, equipment grounding conductors are referred to as bonding conductors.

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5.4 Enclosure and housing

5.4.1 A ground-fault circuit-interrupter housing shall be capable of withstanding the abuses to which it might be subjected in normal use without affecting the GFCI to the extent that the GFCI would fail to comply with the requirements of this Standard. A ground-fault circuit-interrupter intended to be incorporated into equipment having an enclosure that is subject to the requirements of the end-product *Standard, shall be permitted to be constructed without enclosures.

*See Annex D for a list of possible end-product Standards.

5.4.2 A device which is capable of being used as a ground-fault circuit interrupter without being installed in an additional enclosure, shall comply with the enclosure requirements as referenced in Annex A, Ref. No. 3, and shall also comply with the applicable enclosure requirements for the intended environment as referenced in Annex A, Ref. No. 4. See 6.3.8.

5.4.3 Doors and covers shall have means for securing them firmly in place. If bare live parts are exposed by the opening of such doors or covers, means requiring the use of a tool to open, or provision for locking, shall be provided to hold them in the closed position.

5.5 Provision for connection to permanent wiring systems

5.5.1 There shall be provision at a permanently connected ground-fault circuit-interrupter for attachment of raceway or cable and grounding in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, Canadian Electrical Code (CEC), C22.1 or Electrical Installations (Use), NOM-001-SEIE-1999.

5.5.2 Interrupters shall be so constructed that:

- a) The position of the openings for conduit or cable connection is unlikely to cause confusion in connecting field-installed conductors;
- b) Field-installed conductors will be separated by barriers from conductors of internal wiring; and from components of interrupters other than wiring terminals; and
- c) Circuit components will be protected from damage during field installation. See Enclosure and housing – performance, Clause 6.3.

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5.6 Insulation

5.6.1 Except as described in 5.6.2 and 5.6.3, a portable ground-fault circuit-interrupter shall have double insulation or reinforced insulation throughout its construction.

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

5.6.3 In performing the evaluation described in 5.6.2 at a manual switch in the supervisory circuit (described in 5.15.1), 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.

5.6.4 Functional insulation shall be interposed between grounding conductors 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.

5.6.5 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 5.10.5.

5.7 Accessibility of energized parts

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

5.7.2 In determining compliance with the provisions of 5.7.1:

- a) Except at a contact of an attachment-plug receptacle, a part is considered to be accessible if it can be touched with a 2.4 mm (3/32-inch) diameter rod,
- b) A permanently connected device shall 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,
- d) A door or cover that must be opened or removed in order to use a ground-fault circuit-interrupter shall be opened or removed, and
- e) Material that is not acceptable as insulation is considered to be conductive.

5.7.3 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.

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5.8 Internal wiring

5.8.1 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 0.205 mm² (24 AWG) is employed. Compliance shall be determined by completion of the impact test and drop test as described in Enclosure and housing – performance, Clause 6.3, and conducting the Visual inspection test, Clause 6.22.

5.8.2 In a portable cord-connected ground-fault circuit-interrupter, at a wire termination or splice there shall be at least one independent means provided which alone could prevent the conductor from becoming free to bridge supplementary or reinforced insulation in the event that the wire should break at the termination or splice. A wire-binding screw or nut shall be suitably prevented from loosening such as with a spring-type lockwasher or equivalent, if such loosening could allow the attached conductor to become free to bridge supplementary or reinforced insulation. Compliance shall be determined by conducting the Visual inspection test, Clause 6.22.

5.8.3 Insulated conductors shall be suitable for the temperature, voltage, and the intended use in accordance with the applicable requirements of relevant component Standards (see also Separation of circuits, subclause 5.12.4).

5.8.4 All joints and connections shall be made mechanically secure and shall provide adequate and reliable contact without strain on connections and terminals. Compliance shall be determined by conducting the Visual inspection test, Clause 6.22.

5.8.5 All joints shall be provided with insulation suitable for the temperature, voltage, and intended use of the conductors themselves, in accordance with applicable requirements of the relevant component Standards listed in Annex A, Ref. No. 5, or shall comply with Spacings, Clause 5.12, or Alternate spacings – clearances and creepage distances, Clause 5.13. Compliance shall be determined by conducting the Visual inspection test, Clause 6.22.

5.9 Field wiring

5.9.1 A ground-fault circuit-interrupter intended for permanent connection to the branch circuit shall be provided with means for the connection of wires having an ampacity in accordance with the National Electrical Code ANSI/NFPA 70, and the Canadian Electrical Code, C22.1, and Electrical Installations (Use), NOM-001-SEDE.

5.9.2 In a permanently connected ground-fault circuit-interrupter, either:

- a) Acceptable barriers shall be employed to separate load-circuit conductors and terminals from terminals and conductors of any other circuit, or
- b) All such parts shall be insulated for the maximum voltage of either circuit.

5.9.3 If a ground-fault circuit-interrupter is provided with leads for connection to the branch circuit, the leads shall not be more than two sizes smaller than the size referred to in 5.9.1 and shall not be smaller than 2.082 mm² (14 AWG).

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5.9.4 A lead-type terminal shall be so constructed as to withstand the stress of normal handling without damage to the ground-fault circuit-interrupter. To determine compliance, each terminal lead shall be subjected to the force described in 6.1.5.

5.9.5 Green coloring with or without one or more yellow stripes and white or gray coloring shall not be used for the covering of a terminal lead unless intended for connection to grounding and grounded conductors respectively. See also 8.2.4.

In Canada, an equipment grounding conductor is referred to as a bonding conductor and the grounded conductor is referred to as the identified conductor.

5.9.6 The free length of a terminal lead shall be at least 100 mm (4 inches).

5.9.7 A terminal connector shall be prevented from moving so as to strain factory connections or reduce spacings to unacceptable values. Friction alone is not to be depended upon to prevent such movement.

5.9.8 At a terminal that is not considered to be a pressure terminal connector, it shall not be necessary to assemble or adjust parts other than loosening or tightening a screw, bolt, or nut. In order to determine compliance with the provisions of 5.9.8, a wire-binding screw or nut is to be tested in accordance with 6.1.8.

5.9.9 A terminal connector of the wire-binding type is permitted to terminate conductors no larger than 5.26 mm² (10 AWG).

5.10 Power-supply cord

5.10.1 A cord-connected ground-fault circuit-interrupter shall be provided with an attachment plug for connection to the supply circuit. The rating of the attachment plug is to be equal to the rating of the ground-fault circuit-interrupter.

5.10.2 The flexible cord shall be of a type, which complies with the requirements for:

- a) Hard usage or extra-hard usage in accordance with Table 11 of the Canadian Electrical Code, Part I, or
- b) Hard service or junior hard service cords in accordance with Flexible Cords and Cables, Table 400-4 of the National Electrical Code, ANSI/NFPA 70, or
- c) Extra-hard service or hard service in accordance with Electrical Products, Wire and Cables, Heavy Duty and Extra Heavy Duty Flexible Cords, Up to 600 V, NMX-J-436.

5.10.3 Strain on the power-supply cord that may occur by way of pulling, twisting, or pushing into the ground-fault circuit-interrupter housing shall not be transmitted to cord-conductor terminations.

5.10.4 In order to determine that the strain of pulling on the supply cord will not be transmitted to the cord terminations as provided in 5.10.3, the power supply cord is to be subjected to be the test in 6.1.6.

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5.10.5 A clamp or similar device of conductive material applied to the power-supply cord shall have supplementary insulation interposed between the cord and the clamping device or shall not be accessible.

5.10.6 A surface of a ground-fault circuit-interrupter against which a flexible cord is likely to bear shall be smooth and well-rounded.

5.10.7 Unless protection is provided in a ground-fault circuit-interrupter to prevent overloading of the supply-cord conductors, the current rating of the supply cord shall not be less than the current rating of the attachment plug on the supply cord.

5.10.8 The points within the ground-fault circuit-interrupter intended for the termination of power-supply-cord conductors shall be plainly identified as detailed in 7.4.3.

5.10.9 The attachment plug of a ground-fault circuit-interrupter shall be a molded-on type or shall have the cord-conductor terminations sealed, or shall be provided with other means to prevent accidental contact between the grounding conductor and either or both of the power conductors, within the attachment plug.

5.10.10 A portable ungrounded ground-fault circuit-interrupter shall be provided with a polarized attachment plug cap.

5.10.11 If a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connections shall comply with Figure 5.10.1, and the polarity identification of the flexible cord shall comply with Table 5.10.1.

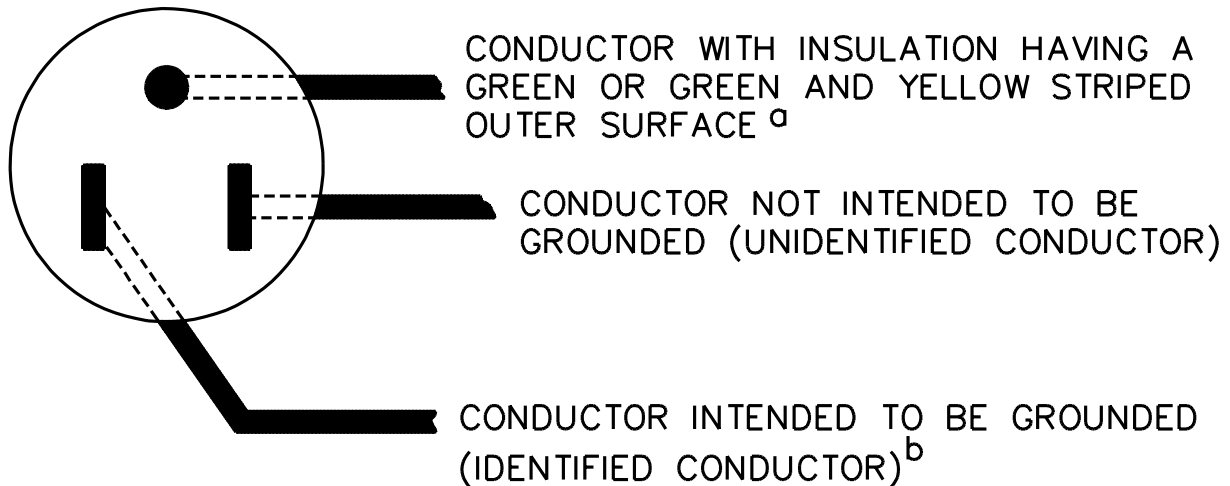
5.10.12 The power supply cord of a portable GFCI having a permanently attached cord shall be subjected to the test in 6.1.7.

5.10.13 The power-supply cord shall be separately insulated from exposed metal parts at the point where it enters the equipment. The jacket on a cord is not considered as supplementary insulation.

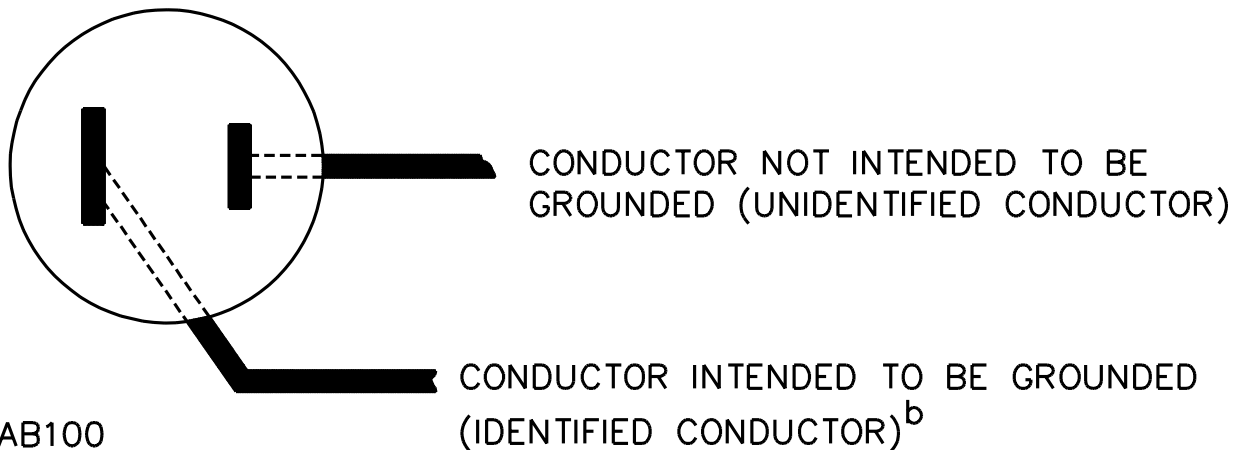
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Figure 5.10.1
Connection to attachment plug

CONNECTIONS OF CORD CONDUCTORS TO GROUNDING – TYPE
ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



CONNECTIONS OF CORD CONDUCTORS TO POLARIZED
ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



AB100

^a In the above illustration, the blade to which the green conductor is connected may have a U-shaped or circular cross section.

^b Signifies a conductor identified in accordance with Table 5.10.1 as wire intended to be grounded.

Table 5.10.1
Polarity identification of flexible cords

Method of Identification	Acceptable combinations	
	Wire intended to be grounded ^{b,c}	All other wires ^b
Color of braids on individual conductors	A Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	B Color other than white or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation ^a on individual conductors	C Solid white or gray	Solid color other than white, or gray
	D Light blue	Solid color other than light blue, white
Note: In Canada, an equipment grounding conductor is referred to as a bonding conductor and the grounded conductor is referred to as the identified conductor.		
^a Only for cords having no braid on any individual conductor.		
^b Wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment-grounding conductor. See Figure 5.10.1.		
^c The color blue or use of a tracer braid is not permitted for this use in Canada.		

5.11 Receptacles

5.11.1 A receptacle of a ground-fault circuit-interrupter shall be of the grounding type with the grounding terminal conductively connected to the grounding conductor of the power-supply cord, except as noted in 5.11.2.

5.11.2 A portable ground-fault circuit-interrupter that is not provided with an equipment ground shall not be provided with a receptacle or cord connector of the grounding type, but shall be provided with a polarized receptacle or cord connector. See 5.5.

5.11.3 The ampere rating of the receptacle of a ground-fault circuit-interrupter that has only a single receptacle shall be equal to the rating of the attachment plug of the supply cord.

5.11.4 The rating of any receptacle not having individual overcurrent protection, provided on a ground-fault circuit-interrupter having more than one receptacle outlet, shall be one of those shown in Table 5.11.1.

5.11.5 The face of a two-conductor ungrounded receptacle or cord connector shall obstruct the insertion of a 2-pole 3-wire grounding type attachment plug cap.

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Table 5.11.1
Receptacle current rating in amperes

Supply – Cord Cap Amperes	15	20	30
Receptacle	15	15 or 20	30

5.12 Spacings

5.12.1 General

5.12.1.1 A through-air spacing between bare, current-carrying parts shall be considered to be the shortest distance measured around any insulating barriers between them, except that any joint in a barrier shall be treated as a gap in the barrier, unless the joint has been shown to have an effective dielectric strength equivalent to that of the barrier.

5.12.1.2 An over-surface spacing between bare, current-carrying parts shall be considered to be the shortest distance measured along the surface of the insulating material between them, except that the following distances shall not be included:

- a) The length of the contour of a slot or groove where the width of the slot or groove in the surface is less than 0.8 mm (1/32 inch) wide.
- b) The distance measured around an insulating barrier which is not integral with its supporting base and not otherwise joined to it so that the dielectric strength of the joint is effectively equivalent to that of the barrier.

5.12.1.3 In determining spacings, film-coated magnet wire is considered to be un-insulated.

5.12.1.4 Parts not locked in position, parts subject to random orientation (such as non-circular heads of screws), and the like are to be moved to the most adverse position for spacing measurement.

5.12.1.5 The spacing at wiring terminals shall be measured with appropriate wires in place and connected to the terminals as in actual service.

5.12.1.6 All bare current-carrying parts connected to different circuits shall be spaced from each other as though they were parts of opposite polarity and spacing requirements shall be judged on the basis of the voltage involved. In the case of isolated circuits, the polarity and spacing between the adjacent bare conductors of the two circuits shall be consistent with the requirements of the highest voltage involved.

5.12.1.7 In determining spacings through openings in a housing of insulated material, tightly drawn metal foil may be used to bridge the opening, but is not to be pressed into the opening.

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5.12.2 Requirements – other than field-wiring terminals

5.12.2.1 Through-air and over-surface spacings shall not be less than the values shown in Table 5.12.2.1 and Table 5.12.2.2.

5.12.3 Requirements – field-wiring terminals

5.12.3.1 The spacings between field-wiring terminals not operating at the same potential shall not be less than those shown in Table 5.12.3.1.

5.12.4 Separation of circuits

5.12.4.1 Unless supplied with insulation suitable for the highest voltage, insulated conductors of different circuits (internal wiring) shall be separated by barriers or shall be segregated; and shall be separated or segregated from bare live parts connected to different circuits. Clamping, routing, or equivalent means of permanent separation from insulated or bare live parts of a different circuit may be considered as appropriate segregation of the insulated conductors.

Table 5.12.2.1
Spacing in mm (inches)

Parts separated by	Operating potential between parts							
	70 V peak or less				71 – 200 V peak			
	Through air		Over surface		Through air		Over surface	
	Open ^a	Closed-in ^b	Open ^a	Closed-in ^b	Open ^a	Closed-in ^b	Open ^a	Closed-in ^b
Functional insulation ^c	1.6 (1/16 ^d)	1.6 (1/16 ^d)	1.6 (1/16 ^d)	1.6 (1/16 ^d)	3.2 (1/8)	1.6 (1/16)	6.4 (1/4)	1.6 (1/16)
Supplementary insulation	3.2 (1/8)	1.6 (1/16)	6.4 (1/4)	1.6 (1/16)	3.2 (1/8)	1.6 (1/16)	6.4 (1/4)	3.2 (1/8)
Double or Reinforced insulation	6.4 (1/4)	3.2 (1/8)	12.7 (1/2)	3.2 (1/8)	6.4 (1/4)	3.2 (1/8)	12.7 (1/2)	6.4 (1/4)
^a A space that is not specially protected from deposition of dirt. ^b A space that is specially protected from deposition of dirt; i.e., a sealed housing that meets the requirements of the dust test outlined in Clause 6.20. ^c Smaller spacings may be acceptable where they are inherent in a suitable component. ^d May be less than 1.6 mm (1/16 in), but not less than 0.8 mm (1/32) at a printed wiring board without conformal coating. ^e For printed wiring boards with suitable conformal coating which has been determined to comply with the requirements in Annex A, Ref. No. 6 spacings may be reduced to 0.8 mm (1/32 in), and may be further reduced if the coating is determined to be suitable and a special dielectric withstand test is performed between the conductors.								

Table 5.12.2.2
Spacing in mm (inches)

Parts separated by	Operating potential between parts			
	201 – 400 V peak			
	Through air		Over surface	
	Open ^a	Closed-in ^b	Open ^a	Closed-in ^b
Functional insulation ^c	6.4 (1/4)	3.2 (1/8)	9.5 (3/8)	3.2 (1/8)
Supplementary insulation	6.4 (1/4)	1.6 (1/16)	9.5 (3/8)	3.2 (1/8)
Double or Reinforced insulation	12.7 (1/2)	6.4 (1/4)	19 (3/4)	6.4 (1/4)

^a A space that is not specially protected from deposition of dirt.
^b A space that is specially protected from deposition of dirt; i.e., a sealed housing that meets the requirements of the dust test outlined in Clause 6.20.
^c Smaller spacings may be acceptable where they are inherent in a suitable component.
^d May be less than 1.6 mm (1/16 in), but not less than 0.8 mm (1/32) at a printed wiring board without conformal coating.
^e For printed wiring boards with suitable conformal coating which has been determined to comply with the requirements in Annex A, Ref. No. 6 spacings may be reduced to 0.8 mm (1/32 in), and may be further reduced if the coating is determined to be suitable and a special dielectric withstand test is performed between the conductors.

Table 5.12.3.1
Minimum spacing at field wiring terminals

Voltage peak	Spacing, mm (inches)		
	Through air (between opposite polarities)	Over surface in air (between opposite polarities)	Through air or over surface (between live parts to ground)
up to 200	6.4 (1/4)	6.4 (1/4)	6.4 (1/4)
201 – 400	9.5 (3/8)	9.5 (3/8)	12.7 (1/2)

5.13 Alternative spacings – clearances and creepage distances

5.13.1 As an alternative to the measurement method specified in Spacings, Clause 5.12, for functional insulation, the minimum acceptable clearances (through air spacings) and creepage distances (over surface spacings) for a printed wiring board assembly shall be evaluated as specified in 5.13.2 – 5.13.4 using the applicable requirements in Annex A, Ref. No. 7.

5.13.2 When applying the requirements in Annex A, Ref. No. 7, the environment for a printed wiring board assembly within a ground-fault circuit-interrupter is considered to be:

- a) Pollution degree 3 for an assembly without a conformal coating,
- b) Pollution degree 2 for
 - 1) an assembly with a conformal coating, or
 - 2) an assembly without a conformal coating when the printed wiring board is contained in a sealed housing that complies with the Dust test, Clause 6.20, or
- c) Pollution degree 1 for an assembly with a conformal coating complying with the Printed Wiring Board Coating Performance Test in Annex A, Ref. No. 7.

5.13.3 When applying Clearance B (controlled overvoltage) construction requirements from Annex A, Ref. No. 7, the applicable overvoltage category for line voltage circuits is Category III. Category I is applicable to low voltage circuits if a short circuit between the parts involved results in operation of the controlled equipment which increases the risk of fire, the risk of electric shock, or both. Any overvoltage protection device needed to achieve these categories shall be provided as an integral part of the ground-fault circuit-interrupter.

5.13.4 Where measurement of clearances and creepage distances is involved to establish the minimum spacings, the methods specified for measurement of clearance and creepage distances in Annex A, Ref. No. 7, shall be used.

5.14 Operating mechanism

5.14.1 Compliance with the provisions of 6.7.1.1 – 6.7.2.2 shall not be prevented by manipulation or restraint of accessible control levers, knobs, and the like of a ground-fault circuit-interrupter. To verify compliance with 5.14.1, see Operating mechanism test, Clause 6.26.

5.14.2 A ground-fault circuit-interrupter that has tripped in accordance with the provisions of 6.7.1.1 – 6.7.2.2 shall not be capable of automatic reclosure.

5.14.3 If a permanently connected ground-fault circuit-interrupter trips because of a loss of power on the line side, it shall be capable of automatic reclosure when power is restored.

5.14.4 A portable ground-fault circuit-interrupter which trips due to a loss of power on the line side is not prohibited from being provided with the capability of automatic reclosure when power is restored.

5.14.5 A receptacle Type GFCI that contains separate line and load terminals, and that is powered through its load terminals, shall not reset and supply power to its receptacle face or line terminals. See Reverse line-load miswire test, Clause 6.23.

5.14.6 A receptacle type GFCI that contains separate line and load terminals shall comply with 5.14.5 during its initial installation and after reinstallation following a correctly wired installation. If the device is provided with special instructions for removal and reinstallation, the instructions shall be followed during testing. See Clause 6.24.

5.14.7 The requirement of 5.14.6 does not apply to a receptacle type GFCI marked in accordance with 7.3.7.

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5.15 Supervisory circuit

5.15.1 A ground-fault circuit-interrupter shall be provided with a supervisory circuit that will conveniently allow for periodic, manual testing of the ability of the device to trip by way of a simulated ground fault.

5.15.2 If it is necessary to employ a separate tool in order to operate the supervisory circuit, operation is considered not to be convenient within the intent of these requirements.

5.15.3 The supervisory circuit shall operate to create a current imbalance of the sensing toroid, but shall not rely on the equipment grounding conductor to operate.

5.15.4 The results of the test shall be made known by means of an audible or visual indication.

5.15.5 When the reset is operated, a permanently connected ground-fault circuit-interrupter that has reached its end of life shall comply with Clause 6.27.

5.15.6 The current imbalance employed by the supervisory circuit shall be sufficient to cause tripping at 85 percent of rated voltage, provided that at rated voltage the current imbalance shall not exceed 9 mA.

5.16 Auto-monitoring function

5.16.1 In addition to the Supervisory circuit specified in 5.15, a permanently connected ground-fault circuit interrupter shall be provided with an auto-monitoring function that will allow for periodic, automatic testing of the ability of the device to respond to a ground fault. This testing shall be done without opening the circuit interrupter contacts.

5.16.2 With the GFCI wired normally (not reversed), the auto-monitoring function shall perform the automatic test each time power becomes available to the load terminal(s) or alternatively line terminal(s) of a properly wired GFCI. The automatic test shall be initiated within five seconds of power availability to the line or load terminals. The automatic test shall be repeated at least every three hours.

5.16.3 The auto-monitoring function shall not compromise the ability of the GFCI to respond to a ground fault or a grounded neutral fault. Compliance is determined by the test of 6.31.6.

5.16.4 The consequence of the auto-monitoring test detection of a problem shall be one or more of the following:

- a) Power denial (trip with the inability to reset);
- b) Trip with the ability to reset, subject to the next auto-monitoring test cycle or repeatedly trip;
- c) Visual and/or audible indication as permitted by 6.31.8.

6 Tests

6.1 General

6.1.1 When evaluated in accordance with 6.1.2, a product having integral blades for direct insertion into a receptacle shall comply with the specifications in Table 6.1.1.

6.1.2 The limits specified in Table 6.1.1 shall 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.
- c) A removable part is to be in place.
- d) A mounting tab is not to be included in the measurement of linear dimensions for the purpose of determining moments unless:
 - 1) There is no deformation of the tab and enclosure after being subjected to the impact described in Enclosure and housing – performance, Clause 6.3, and
 - 2) For a polymeric-enclosed product having an integral tab, there is no distortion at temperatures to which the polymeric material may be subjected under conditions of normal and abnormal use as determined by subjecting the product to the applicable mold stress-relief distortion test requirements in Annex A, Ref. No. 8.

6.1.3 When the integral blades are inserted into a parallel-blade duplex receptacle, no part of the product, including a mounting tab, shall interfere with the full insertion of an attachment plug into the adjacent receptacle, except as noted in 6.1.4. See Figure 6.1.2.

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

Table 6.1.1
Specifications for plug-in GFCIs

Algebraic Quantity	Maximum acceptable value	
W	(7.78 N)	28 ozf
WY/Z	(13.34 N)	48 ozf
WY/S	(13.34 N)	48 ozf
WX	(0.56 N·m)	80 ozf-in.

In this table the variables are defined as follows:

W is the weight of the product in N (ozf) and is considered to be a force equal to the product mass in kg (oz) as measured on a scale or balance.

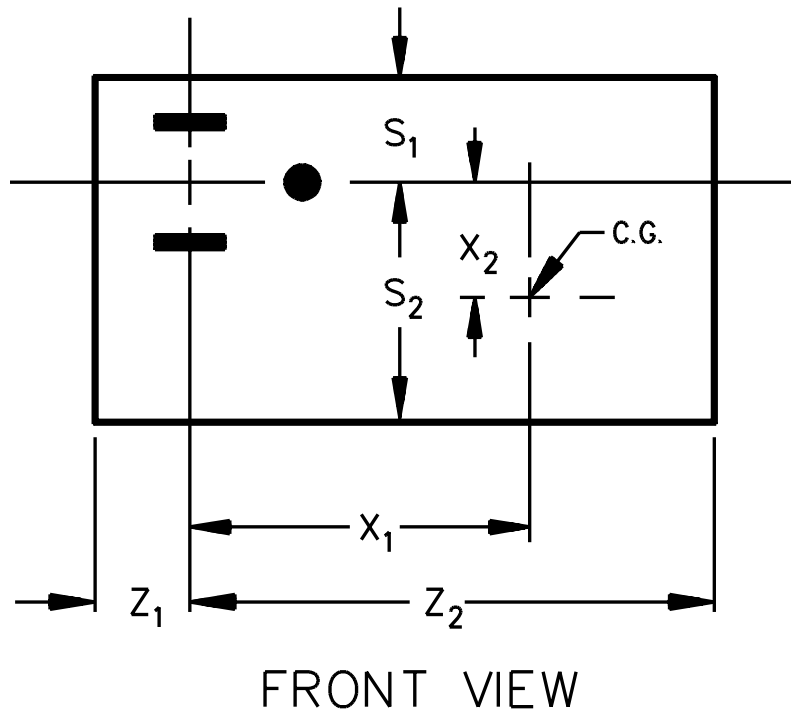
Y is the distance, in mm (inches), illustrated in Figure 6.1.1.

Z is the shorter distance, in mm (inches), of Z_1 or Z_2 illustrated in Figure 6.1.1.

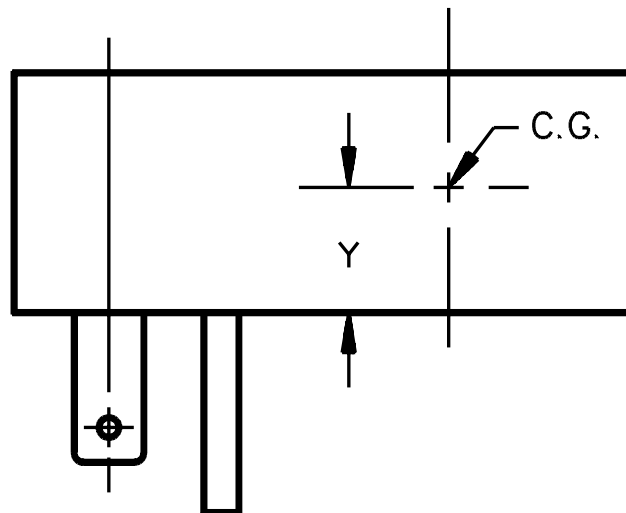
S is the shorter distance, in mm (inches), of S_1 or S_2 illustrated in Figure 6.1.1.

X is the shorter distance, in mm (inches), of X_1 or X_2 illustrated in Figure 6.1.1.

Figure 6.1.1
Dimensions of a plug-in product



FRONT VIEW



SIDE VIEW

C.G. = Center of Gravity

CP100A

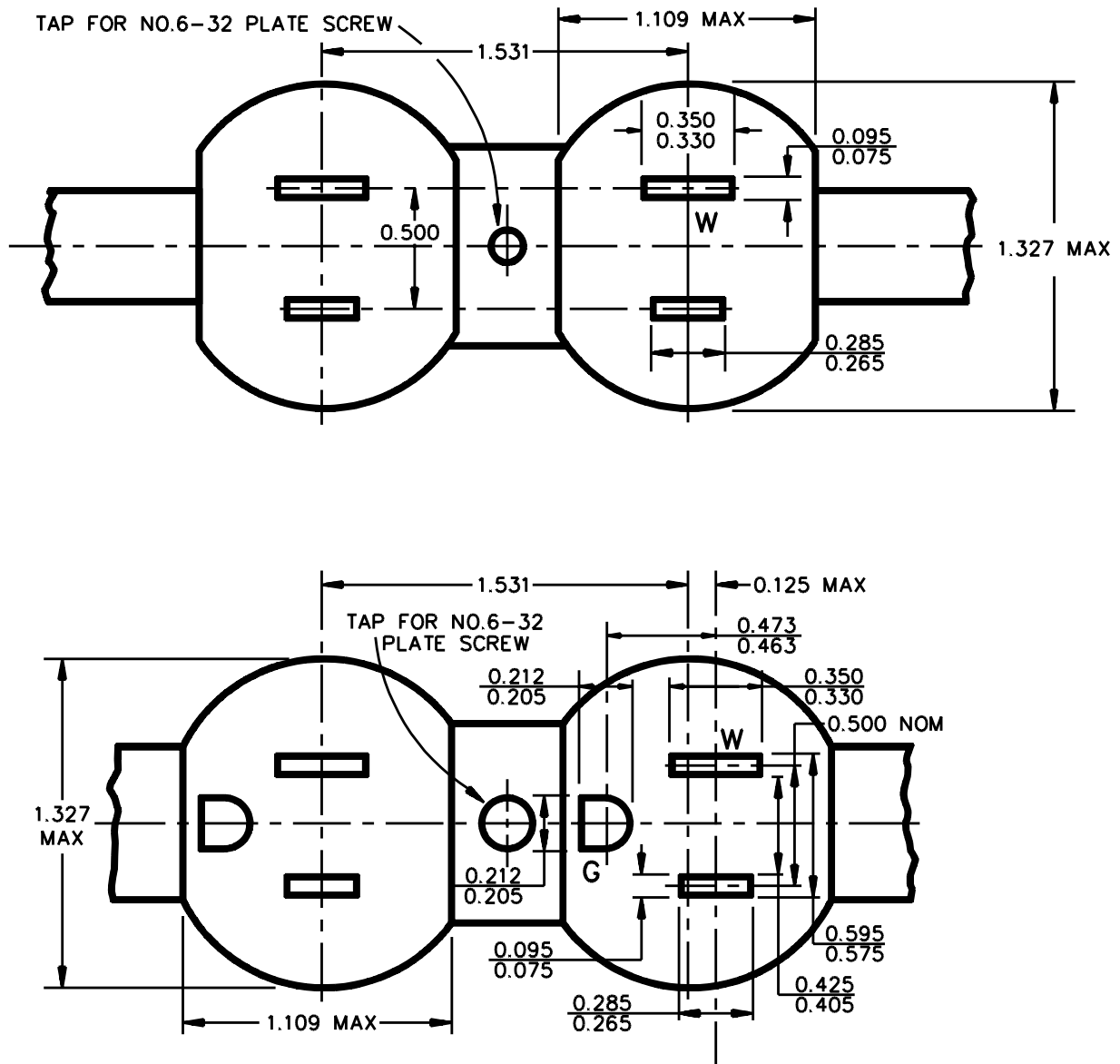
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Figure 6.1.2
Parallel duplex receptacle



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6.1.5 Each field wiring terminal lead mentioned in 5.9.4 is to withstand a tensile force increased gradually to 89 N (20 lbf), and maintained at that value for five minutes.

6.1.6 In order to determine that the strain of pulling on the power-supply cord mentioned in 5.10.4 will not be transmitted to the cord terminations, a tensile force is to be applied to the cord and increased gradually to 156 N (35 lbf). The force is to be maintained at 156 N (35 lbf) for one minute.

6.1.7 The power-supply cord of a portable GFCI having a permanently attached cord mentioned in 5.10.12 shall be subjected to a pull equal to three times the weight of the equipment. The test shall be repeated ten times with the pull being applied each time for 1 s without jerks. The strain relief shall be judged to comply with the Standard if the cord has not been displaced by more than 2.4 mm (0.094 in) and there is no evidence of any strain being imposed on the wiring connections.

6.1.8 In order to determine compliance with the provisions of 5.9.8, a wire-binding screw or nut is to be tightened on a conductor selected in accordance with the provisions of 5.9.1 to a torque of 2.3 N·m (20 lbf-in) without causing displacement of the wire or damage to the terminal assembly or the wire. Except where the configuration of the terminal assembly does not permit it, or markings allow the use of unformed wire, the wire is to be formed into a 3/4 loop that will just be accommodated by the assembly, before tightening.

6.2 Polymeric enclosures

6.2.1 General

6.2.1.1 A polymeric enclosure, or a polymeric part of an enclosure of a ground-fault circuit-interrupter shall comply with the Standard for the polymeric enclosure as specified in Annex A, Ref. No. 9, except as noted in 6.2.1.2.

6.2.1.2 For a direct plug-in ground-fault circuit-interrupter, the crushing test shall be conducted in accordance with Annex A, Ref. No. 1.

6.2.1.3 An adhesive used in the assembly of a ground-fault circuit-interrupter shall comply with the applicable requirements for adhesives in accordance with the applicable requirements in Annex A, Ref. No. 10, except as noted in 6.2.1.4.

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

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