UL 69

STANDARD FOR SAFETY

Electric-Fence Controllers

UL Standard for Safety for Electric-Fence Controllers, UL 69

Tenth Edition, Dated June 30, 2009

Summary of Topics

This revision of UL 69 dated February 20, 2024 is being issued to reaffirm approval as an American National Standard. No changes in requirements are involved.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated January 5, 2024.

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Standard for Electric-Fence Controllers

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The most recent designation of ANSI/UL 69 as a Reaffirmed American National Standard (ANS) occurred on February 20, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover electric-fence controllers to be employed on lighting or line circuits in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements cover electric-fence controllers used only for the control of animals.

1.3 These requirements cover portable and permanently mounted electric-fence controllers with peak-discharge or sinusoidal-discharge output for indoor or outdoor use, including battery-operated controllers intended to operate from battery circuits of 42.4 V or less, line-operated controllers intended to operate from circuits of 125 V or less, combination controllers intended to operate from either a battery or a line circuit, and photovoltaic module battery operated controllers.

1.4 These requirements do not cover electric-fence controllers for the continuous (uninterrupted) current type or intermediate equipment, such as a converter, a rectifier, or the like, that is sometimes used between the primary source of supply and an electric-fence controller and that is investigated only as part of a complete controller.

1.5 These requirements do not cover electric-fence controllers for use with electrified security fences.

2 Components

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

2.2 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 superceded by a requirement in this standard.

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

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

3 General

3.1 Units of measurement

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

3.2 Undated references

3.2.1 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.

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 CONTINUOUS CURRENT OUTPUT – Output current which has a steady-state peak of 7.0 mA or more.

4.3 CURRENT PULSE – The current which flows during the time period in which 95 percent of the output energy of a single fence controller output waveform has been transferred to the load resistor.

4.1 DIRECT PLUG-IN CONTROLLER – An electric fence controller for indoor use only with a single output which employs a blade assembly on the enclosure for connection to the branch circuit. The controller may be provided with output wiring or wire binding screws intended for connection to solid wire. Not considered a direct plug-in power supply that is detachable from the electric fence controller.

4.4 ELECTRICAL BREAKDOWN – Occurs when a discharge bridges the insulation under test, reducing the voltage between the electrodes to zero or nearly zero.

4.5 EQUIPMENT GROUNDING MEANS – A lead or terminal, provided in the splice compartment of a permanently mounted fence controller, that is intended for connection to the branch circuit (supply) grounding conductor; or the grounding pin of an attachment plug of a 3-wire power supply cord, provided on a portable fence controller, that is intended for connection to the branch circuit (supply) grounding conductor.

4.6 FENCE TERMINAL – The output terminal that is not intended to be connected to earth ground.

4.7 LEAKAGE CURRENT – Any current that may be conveyed from accessible parts, other than the fence output terminals, to ground or to other accessible parts.

4.8 OUTPUT GROUND TERMINAL – The output terminal that is intended to be connected to the fence ground rod.

4.9 PEAK-DISCHARGE OUTPUT – Output current pulses that are unidirectional single impulses.

4.10 PERMANENTLY CONNECTED CONTROLLERS – Connected to branch circuit wiring by a means other than a cord and plug, such as by using conduit.

4.11 PERMANENTLY MOUNTED CONTROLLERS – Secured to a mounting surface by a means that requires the use of a tool for removal.

4.12 PORTABLE CONTROLLER – A cord connected controller that is mounted by means not requiring a tool for removal and not intended for permanent mounting.

4.13 PULSE SEGMENT – A part of a current pulse that is between any two points in time within the duration of the current pulse.

4.14 SECONDARY CIRCUITS – Those circuits supplied from transformer output windings that are electrically separated from the input windings.

4.15 SINUSOIDAL-DISCHARGE OUTPUT – Output current pulses that are oscillatory current waveforms.

4.16 SUPPLEMENTARY (PROTECTING) INSULATION – An independent insulation provided in addition to basic insulation to protect against electric shock in case of mechanical rupture or electrical breakdown of the basic insulation. An enclosure of insulating material may form a part or the whole of the supplementary insulation.

4.17 SUPPLY CIRCUIT – The branch circuit supplying electrical energy to the fence controller.

CONSTRUCTION

5 General

5.1 A fence controller shall employ materials that are acceptable for the use.

5.2 An enclosure, an opening, a frame, a guard, a knob, a handle, or the like shall not be sufficiently sharp to constitute a risk of injury in normal maintenance or use.

6 Enclosure

6.1 General

6.1.1 A fence controller shall be provided with an enclosure that, except for the fence terminals, will enclose all uninsulated live parts. The enclosure shall be constructed of metal or polymeric material that complies with the requirements for Polymeric Materials, Section 20.

6.1.2 The enclosure housing the timing and output mechanism shall be dust and water-resistant as determined by the Humidity and Water-Spray Test, Section 28, and the Hosedown Test, Section 29.

6.1.3 The enclosure shall be formed so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without resulting in a risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other defects. See 6.1.4 and 20.5.

6.1.4 To determine compliance with 6.1.3, a fence controller shall be subjected to the applicable tests specified in Section 30, Impact Test.

6.1.5 The enclosure of a fence controller shall be tamper-resistant to the extent that the use of a tool, other than an ordinary tool such as a screwdriver, pliers, or a wrench, or partial destruction of the enclosure is necessary to gain access to the timing mechanism or circuit or to any other part that tampering with may result in a risk of fire, electric shock, or injury to persons.

6.1.6 The degree to which the enclosure is required to be tamper-resistant is determined in part by the type of current-limiting means employed, the type of timing mechanism or circuit employed, and any auxiliary device that would function to make the controller inoperable in the event of tampering. Sealing wax applied over a screwhead or in a recess to conceal a bolt head or nut is not considered to be an acceptable means for making an enclosure tamper-resistant.

6.1.7 The tamper-resistant enclosure shall completely house all live parts if tampering with such parts may result in a risk of fire, electric shock, or injury to persons.

Exception: The screw shell of a lampholder or fuseholder that is not completely within the enclosure, the supply cord or wiring terminals, and the terminals for connecting the fence and grounding conductors need not be enclosed.

6.1.8 Leads or terminals for primary connections of a fence controller, that are located outside the tamper-resistant enclosure shall be housed within a supplementary enclosure.

Exception: This requirement does not apply to a portable, indoor, battery-operated fence controller if it complies with the requirements in 10.3.1.8.

6.1.9 A battery-operated fence controller marked "Outdoor Use" as specified in 38.2 shall have provision for completely enclosing the battery leads.

Exception: This requirement does not apply to a battery-operated fence controller provided with leads that are marked for outdoor use with "Water Resistant," "W," and "W-A" or the word "Outdoor," or other equivalent marking. See 10.2.3.

6.2 Doors and covers

6.2.1 A door, cover, or the like employed as a supplementary enclosure shall be provided with means, such as locks, interlocks, screws, and seals, for securing it firmly in place.

6.2.2 A door or cover that provides access to a fuse, thermal cutout, or other overload-protective device or control switch that requires access by the user shall be hinged, sliding, or similarly attached, so that it cannot be removed without the use of tools.

6.2.3 A hinged cover shall be so attached to the enclosure that it will close by gravity when the fence controller is installed and mounted in its intended manner.

Exception: A cover need not close by gravity if it is investigated and found to be acceptable for the application, or if it will not create a risk of fire, electric shock, or injury to persons if left open.

6.3 Thickness

6.3.1 Cast metal for an enclosure shall not be less than 1/8 in (3.2 mm) thick at every point, and shall have a greater thickness at reinforcing ribs and door edges, except that die-cast metal may not be less than 1/16 in (1.6 mm) for an area of 24 in^2 (155 cm^2) or less and having no dimension greater than 6 in (152 mm), and may be not less than 3/32 in (2.4 mm) for an area greater than 24 in^2 or having any dimension greater than 6 in. See 6.3.2.

6.3.2 Cast metal shall be not less than 1/4 in (6.4 mm) thick at threaded holes for conduit.

6.3.3 A sheet steel enclosure shall have a thickness not less than that specified in Table 6.1. See 6.3.4.

Table 6.1
Thickness of enclosure

Maximum dimension of largest surface,		Minimum thickness							
		Sheet steel				Aluminum			
		Unreinforced flat surface,		Reinforced,		Unreinforced flat surface,		Reinforced,	
in	(mm)	in	(mm)	in	(mm)	in	(mm)	in	(mm)
8	(203)	0.032	(0.81)	0.020	(0.51)	0.045	(1.14)	0.036	(0.91)
12	(305)	0.042	(1.07)	0.032	(0.81)	0.058	(1.47)	0.045	(1.14)
18	(457)	0.053	(1.35)	0.042	(1.07)	0.075	(1.91)	0.058	(1.47)
24	(610)	0.067	(1.70)	0.053	(1.35)	0.095	(2.41)	0.075	(1.91)

6.3.4 Sheet metal to which conduit is intended to be connected shall be of such thickness, or shall be formed or reinforced so that it will have a stiffness at least equivalent to that of a 0.060 in (1.52 mm) thick sheet steel.

6.3.5 An enclosure material other than cast metal or sheet steel shall be investigated to determine if it is acceptable for the purpose.

6.4 Openings

6.4.1 Ventilating openings shall be of such size or shape that no opening will permit entrance of a rod having a diameter greater than 1/4 in (6.4 mm) to contact any internal component if the current and voltage available from the component may present a risk of electric shock.

Exception: If the distance between a live part and the enclosure is more than 4 in (102 mm), an opening may be larger provided that:

a) No opening will permit entrance of a rod having a diameter greater than 1/2 in (12.7 mm), and

b) The insertion of a rod for a distance of 4 in through the opening cannot be made to affect the operation of the controller.

6.4.2 A lens that forms a part of an enclosure housing a timing mechanism shall be acceptable for the purpose. See 6.1.1 – 6.1.3, and 20.3.

7 Mounting

7.1 Means shall be provided for securely mounting or otherwise supporting the fence controller in its intended operating position.

7.2 A line- or battery-operated fence controller shall not be provided with a means for permanent mounting unless the supply connections comply with the requirements in 10.2.1 or 10.2.2, respectively. Keyhole slots that may be provided on a portable unit are not considered a means for permanent mounting.

7.3 Bolts, screws, or other parts used for mounting a fence controller shall be independent of those used for securing parts of the fence controller to the frame, base, or panel.

8 Mechanical Assembly

8.1 The assembly of a fence controller shall be such that it will not be adversely affected by the vibration of normal operation.

8.2 An attachment-plug receptacle, a fuseholder, a lampholder, a switch, a plug connector, or the like provided as part of a fence controller shall be mounted securely and shall be provided with means other than friction between surfaces that will reduce the likelihood of turning or shifting.

8.3 A lock washer properly applied is considered to be acceptable as a means to reduce the likelihood of a wiring device turning as mentioned in 8.2.

8.4 Each screw and nut accessible from the outside of the enclosure shall be riveted, staked, filed, or otherwise treated in such a manner as to discourage the user of the fence controller from trying to loosen it in an attempt to gain admittance to the enclosure.

Exception: A screw and nut that can be removed with an ordinary tool may be employed if its removal does not create a risk of fire, electric shock, or injury to persons. See 6.1.6.

8.5 Uninsulated live parts shall be secured to the base or mounting surface so that the likelihood of turning or shifting in position is reduced, if such motion may result in reduction of spacings below the minimum specified in Section 19, Spacings, or may otherwise adversely affect the operation of the fence controller.

9 Protection Against Corrosion

9.1 An enclosure constructed of iron or steel shall be enameled, galvanized, plated, or provided with equivalent corrosion protection, if corrosion of such parts would be likely to result in a risk of fire, electric shock, or injury to persons. Both inside and outside surfaces of an enclosure shall be protected against corrosion.

9.2 If the corrosion of iron or steel parts might result in a risk of fire, electric shock, or injury to persons, and if the adequacy of the corrosion protection provided is in doubt, appropriate exposure tests are to be conducted.

9.3 A ferrous metal enclosure of a fence controller marked "Outdoor Use" shall be protected against corrosion in accordance with Table 9.1.

Exception: A steel enclosure provided with an organic coating may be acceptable if comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with ASTM Coating Designation G90 indicate the coating provides equivalent protection. Among the factors that are to be taken into consideration when investigating the acceptability of such a coating system are exposure to salt spray and moist carbon-dioxide/sulfur-dioxide air mixtures.

Table 9.1
Sheet-metal coatings

Type of coating	Coating designation or thickness in	
	in	(mm)
Hot-dipped, mill-galvanized steel	G90[a]	
Other coating	0.00041	(0.0104)[b]

[a] Conforming with the coating designation G90 in the Weight (Mass) of Coating Requirements Table of the Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653, with not less than 40 percent of the zinc on any side, based on the minimum single-spot-test requirement in this ASTM specification.

[b] Average thickness with a spot minus tolerance of 0.00007 in (0.0018 mm).

10 Supply Connections

10.1 General

10.1.1 Supply connections are considered to be those that are made in the field when a fence controller is installed.

10.1.2 The primary circuit is considered to include primary-supply wiring terminals or leads, supply cords and plugs, and all wiring and circuit components conductively connected to them.

10.2 Permanently mounted controllers

10.2.1 A line-operated fence controller intended for permanent mounting, and marked "Outdoor Use" shall have provision for the connection of conduit.

10.2.2 A battery-operated fence controller intended for permanent mounting and provided with an interconnecting cord shall be provided with Type SJT, SJO, SJTO, or SJE flexible cord, or other jacketed cord acceptable for at least hard usage. The flexible cord shall be provided with a bushing as specified in 10.3.3 and shall be subjected to the Strain Relief Test, Section 34.

10.2.3 A battery-operated fence controller intended for permanent mounting and marked "Outdoor Use" shall be provided with a power supply cord that is in accordance with 10.2.2, and additionally marked with the suffix "W-A," "W," or with the word "Outdoor."

10.2.4 A battery- or line-operated fence controller shall be provided with wiring terminals or leads for the connection of supply conductors. A fixed wiring terminal shall be prevented from turning.

10.2.5 The binding screw of a screw-and-washer construction employed at a wiring terminal shall not be smaller than No. 6 (3.5 mm diameter).

10.2.6 A terminal plate for a wire-binding screw shall be of metal not less than 0.050 in (1.27 mm) thick.

10.2.7 A tapped hole in a terminal plate for a wire-binding screw shall be provided with not fewer than two full threads in the metal. The metal may be extruded at the tapped hole for the binding screw to provide two full threads.

10.2.8 An upturned lug or cupped washer shall be capable of retaining at least a 14 AWG (2.1 mm^2) conductor under the head of a screw or washer, even though the screw becomes slightly loosened.

10.2.9 A wire-binding screw shall not thread into material other than metal.

10.2.10 A permanently mounted fence controller rated at 125 V or less and employing, in the primary circuit, a lampholder of the Edison-screw-shell type or a single-pole switch or overcurrent-protective device shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The identified terminal or lead shall be the one that is conductively connected to the screw shells of lampholders and to which no switches or overcurrent-protective devices of the single-pole type are connected.

10.2.11 A terminal intended for the connection of a grounded power-supply conductor shall be readily distinguishable from the other terminals, and:

a) Identified by a plating that is substantially white in color (such as nickel),

b) Of a metal that is substantially white in color,

c) Otherwise colored white,

d) Marked WH, or

e) Properly identified in some other manner, such as on an attached wiring diagram.

10.2.12 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 readily distinguishable from the other leads.

10.2.13 A wire-binding screw provided in the supply connection compartment of a permanently connected fence controller that is intended for connection of an equipment grounding conductor shall have a green colored head that is slotted or hexagonal, or both. A pressure terminal connector provided in the supply connection compartment of a permanently connected fence controller that is intended for connection of an equipment grounding conductor shall be plainly identified by a marking, such as "G," "GR," "Ground," "Grounding," or the like. A wire-binding screw or pressure terminal connector shall be located so that it will not require removal during normal servicing of the product. See 39.4.1 for additional marking requirements.

10.2.14 A lead provided in the supply connection compartment of a permanently connected fence controller that is intended for the connection of an equipment grounding conductor shall be finished to show a green color with or without one or more yellow stripes, and shall be readily distinguishable from the other leads. See 39.4.1 for marking requirements.

10.3 Portable controllers

10.3.1 Cords and plugs

10.3.1.1 A portable line-operated fence controller shall be provided with one of the following:

a) A 3-conductor flexible cord terminating in an attachment plug that includes a grounding pin for connection of the equipment grounding conductor of the supply cord to the branch circuit (supply) grounding conductor.

b) A 2-conductor power supply cord terminating in an attachment plug for connection to the supply circuit, and double insulation as specified in the Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097. See Installation and Operating Instructions, Section 40.

c) A 2-conductor power supply cord terminating in an attachment plug for connection to the supply circuit but not requiring double insulation, and with a means for grounding provided by an output ground terminal.

d) Other constructions not specified that have been investigated and found acceptable for the application.

10.3.1.2 A portable, battery operated fence controller provided with an external battery shall be provided with a flexible cord for interconnection of the fence controller to the battery.

10.3.1.3 A portable, line-operated fence controller intended for other than outdoor use shall be provided with Type S, SJ, SJO, SJT, SJTO, SO, ST, or STO flexible cord and an attachment plug for connection to the supply circuit.

10.3.1.4 A portable, line-operated fence controller that is marked for outdoor use shall be provided with a Type SJTW-A or SJTW flexible cord marked "Water Resistant" or the equivalent, and an outdoor use attachment plug for connection to the supply circuit.

10.3.1.5 The supply cord of a line-operated fence controller shall terminate in a 3-blade grounding type or a 2-blade polarized type attachment plug. The connections to the attachment plug shall be in accordance with Figure 10.1. See 40.5 for marking.

Exception: A fence controller need not be polarized if it:

a) Is provided with double insulation, and

b) Does not include a line-connected, single-pole switch, a 15- or 20-A rated receptacle, or an Edison base lampholder.

10.3.1.6 For a controller provided with a polarized attachment plug, one of the circuit conductors in the flexible cord shall be identified for connection of the grounded (neutral) supply conductor. The identification of the grounded conductor of the supply cord shall be in accordance with Table 10.1.

10.3.1.7 If provided in a fence controller, a line-connected, single-pole switch shall be connected to the ungrounded circuit conductor.

10.3.1.8 A portable, battery-operated fence controller not intended for outdoor use that does not have provision for completely housing the battery shall be provided with Type SP-2, SPT-2, or hard service cord, or with single-conductor leads having rubber insulation at least the equivalent of that on the conductors of Type S cord and not less than 3/64 in (1.2 mm) thick.

Table 10.1
Polarity identification of flexible cords

Method of identification	Acceptable combinations	
	Wire intended to be grounded[a]	All other wires
Color of braids on individual conductors	Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	Color other than white, or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	Solid white or gray[b] Light blue[c]	Solid color other than white or gray Solid color other than light blue, white or gray

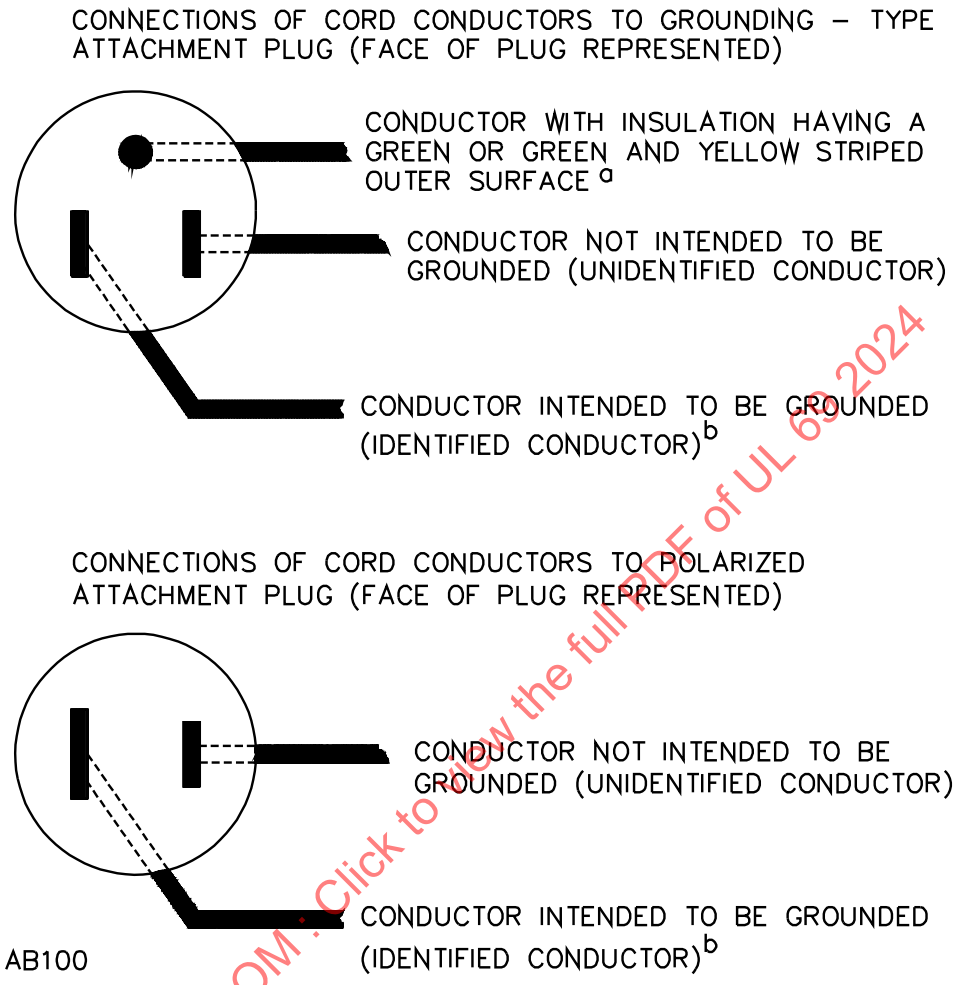
[a] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment-grounding conductor. See 10.2.14 and Figure 10.1.

[b] Only for cords having no braid on any individual conductor.

[c] For jacketed cords.

Figure 10.1

Connections to attachment plugs



[a] In the above illustration, the blade to which the green conductor is connected may have a U-shape instead of a circular cross section.

[b] Signifies a conductor identified in accordance with Table 10.1.

10.3.2 Strain relief

10.3.2.1 Strain relief shall be provided so that mechanical stress on a flexible cord or conductor leads will not be transmitted to a terminal, splice, or interior wiring. See the Strain-Relief Test, Section 34.

10.3.2.2 If a knot in a flexible cord serves as strain relief, the surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, or the like, that might damage the cord.

10.3.3 Bushings

10.3.3.1 At a point where a flexible cord or conductor lead passes through an opening in a wall, barrier, or enclosing case, the hole shall have a smooth, rounded edge or shall be provided with an acceptable bushing.

10.3.3.2 A metal grommet having a smooth, rounded surface and securely fastened in position in the hole is considered to be acceptable as the bushing required by 10.3.3.1.

10.3.3.3 An insulating bushing shall be provided at the point where the fence conductor or fence-conductor terminal passes through the metal enclosure.

10.3.3.4 Rubber, wood, or so-called hot-molded shellac and tar compositions are not considered to be acceptable materials for bushings.

10.4 Direct plug-in controllers

10.4.1 The integral blade assembly of direct plug-in controllers shall comply with the construction requirements in the Standard for Attachment Plugs and Receptacles, UL 498, and Wiring Devices - Dimensional Specifications, ANSI/NEMA WD6, for a 125 V, 15 A, 2 pole, 3 wire, grounded type configuration, and shall not be retractable. See 10.4.7 and 10.4.8.

Exception: A fence controller complying with Supplement SA for double insulation shall be provided with a 125 V, 15 A, 2 pole, two wire type configuration.

10.4.2 If a direct plug-in controllers employs a manually operated line connected single-pole switch or a fuse with an accessible contact, it shall employ a polarized- or grounding-type blade assembly.

10.4.3 The maximum acceptable moment, center of gravity, dimensions, and weight of a direct plug-in controller shall comply with the following requirements, see 10.4.4:

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); and

d) The weight of a controller shall not exceed 28 ounces (794 g).

Where the definitions for the symbols are as follows:

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

Y is the distance illustrated in Figure 10.2 in inches (mm).

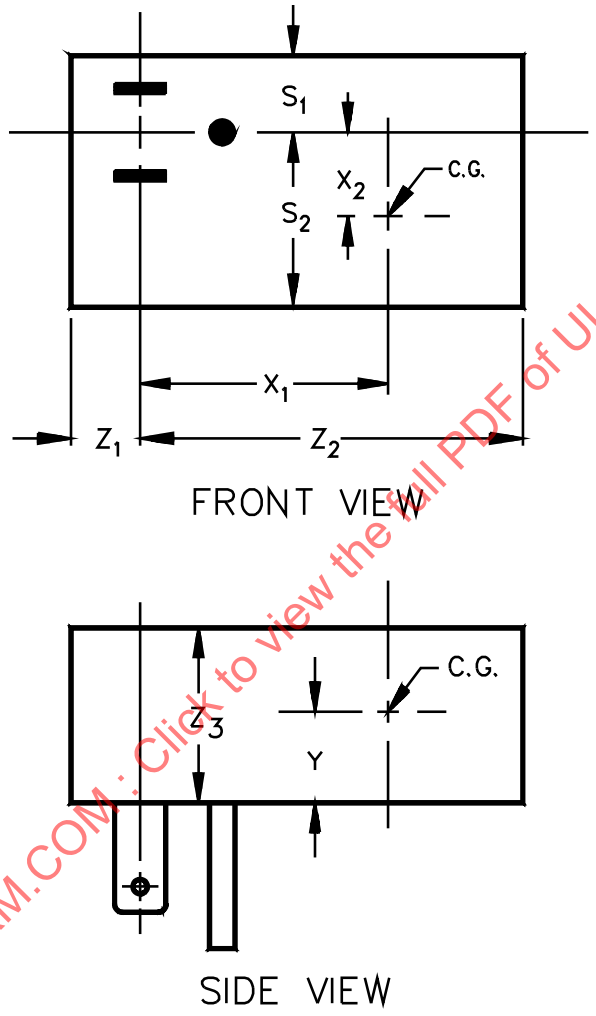
Z is the lesser of the two distances, Z1 or Z2, as illustrated in Figure 10.2 in inches (mm).

S is the lesser of the two distances, S1 or S2, as illustrated in Figure 10.2 in inches (mm).

X is the greater of the two distances, X1 or X2, as illustrated in Figure 10.2 in inches (mm).

Figure 10.2

Dimensions of a direct plug-in controller



C.G. = Center of Gravity

CP100

10.4.4 The moment and weight specified in 10.4.3 are to be determined as follows:

a) For controllers 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 controllers with directly mounted accessories, the values are to be measured with the accessories in place.

c) An integral tab is not to be included in measurements of the linear dimensions for the purpose of determining moments unless:

1) The tab and enclosure withstand the impact described in Section 30 with one impact on the tab itself, without deformation; and

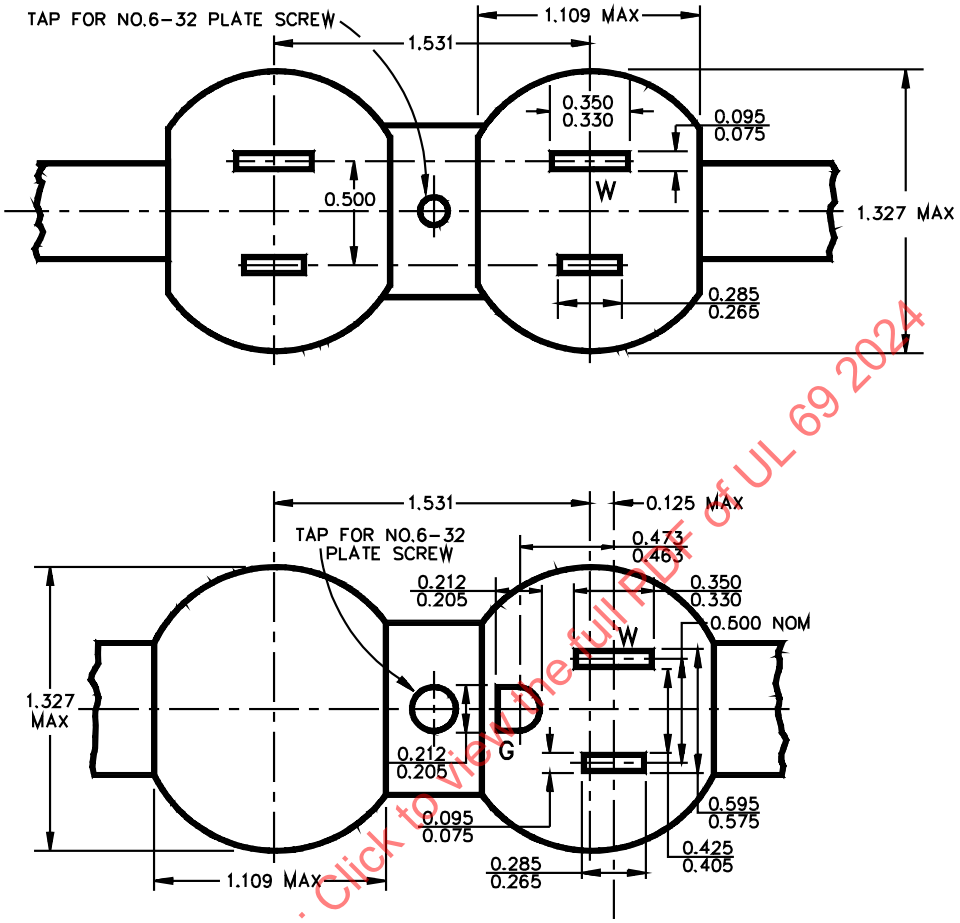
2) For a polymeric enclosed controller having an integral tab, the tab and enclosure do not distort at temperatures to which the material may be subjected under conditions of normal and abnormal use as determined by the mold stress relief distortion test in the Standard for Polymeric Materials - Use in Electrical Equipment Evaluations, UL 746C.

10.4.5 When inserted in a duplex receptacle, no part of a direct plug-in controller, including an integral tab or output wiring, shall interfere with full insertion of an attachment plug into the adjacent receptacle. See Figure 10.3.

Exception: This requirement does not apply to a controller that renders the adjacent receptacle completely unusable in any one mounting position.

Figure 10.3

125V, 15A Duplex receptacle



10.4.6 A mounting tab shall not be provided with a direct plug-in controller unless all of the following conditions are met:

a) A screw is provided and constructed to secure the mounting tab of the controller to a duplex receptacle that has a center screw, see Figure 10.3;

b) For a controller without a grounding pin, the mounting tab is constructed so that the controller may be mounted to both grounding and nongrounding receptacles;

c) A mounting tab does not serve as ground; and

d) The controller shall be provided with an ON/OFF switch complying with any one of the following standards:

1) Standard for Special-Use Switches, UL 1054;

2) Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1; or

3) Standard for General-Use Snap Switches, UL 20.

10.4.7 The enclosure of a controller shall be capable of being gripped for removal from the receptacle to which it is connected, and the perimeter of the face section from which the blades project shall not be less than 0.20 inch (5.1 mm) from any point on either blade. In order to determine compliance with this requirement for controllers with rounded edges, the perimeter of the face section is considered to be the point at which the articulate probe is able to access as shown in Figure 10.5.

10.4.8 With reference to 10.4.7, for an extension from the face for mechanical support of the blades provided as shown in Figure 10.4, the point of measurement shall be determined by application of the articulate probe, Figure 10.6, as shown in Figure 10.5.

Figure 10.4

Extension for mechanical support of blades

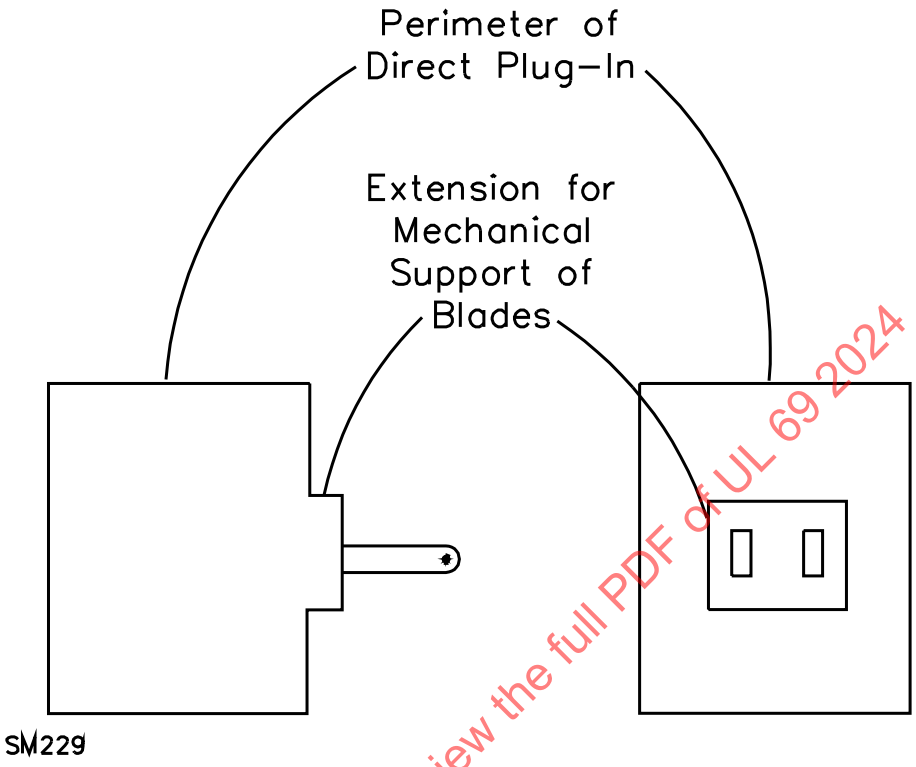


Figure 10.5

Determination of perimeter of controllers with rounded edges

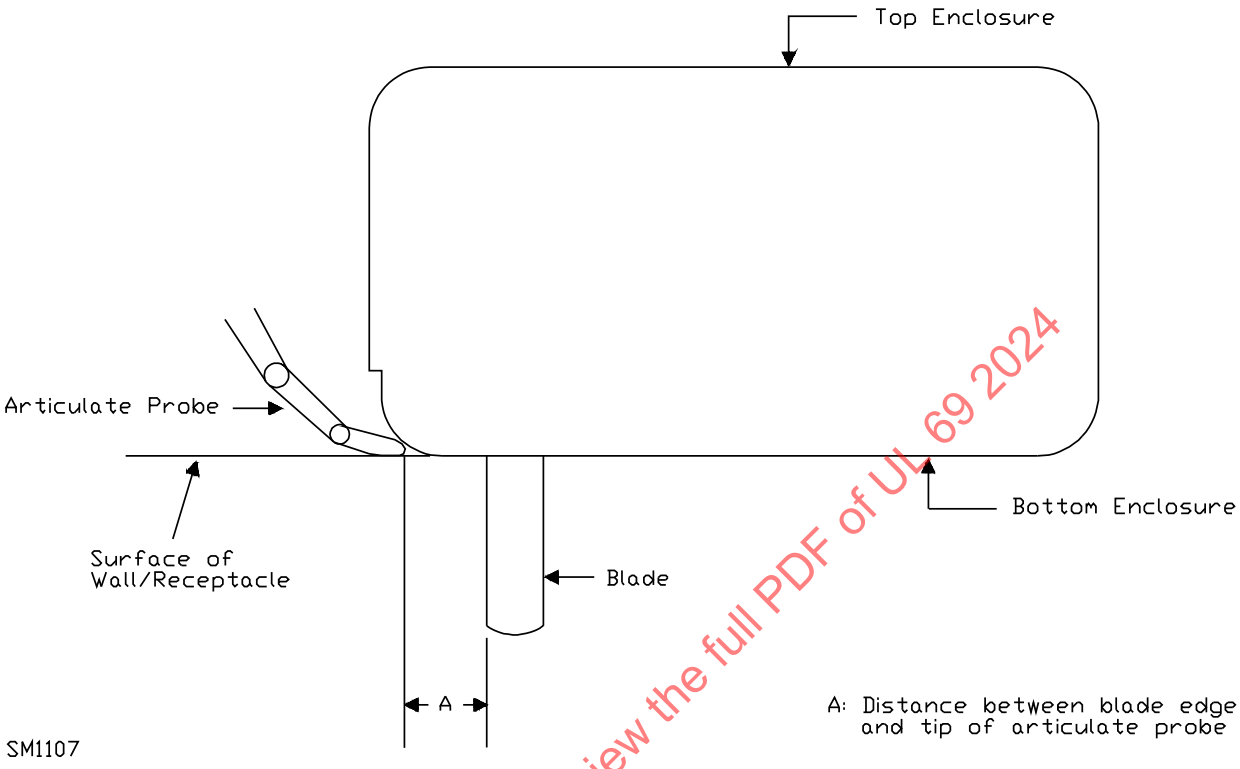
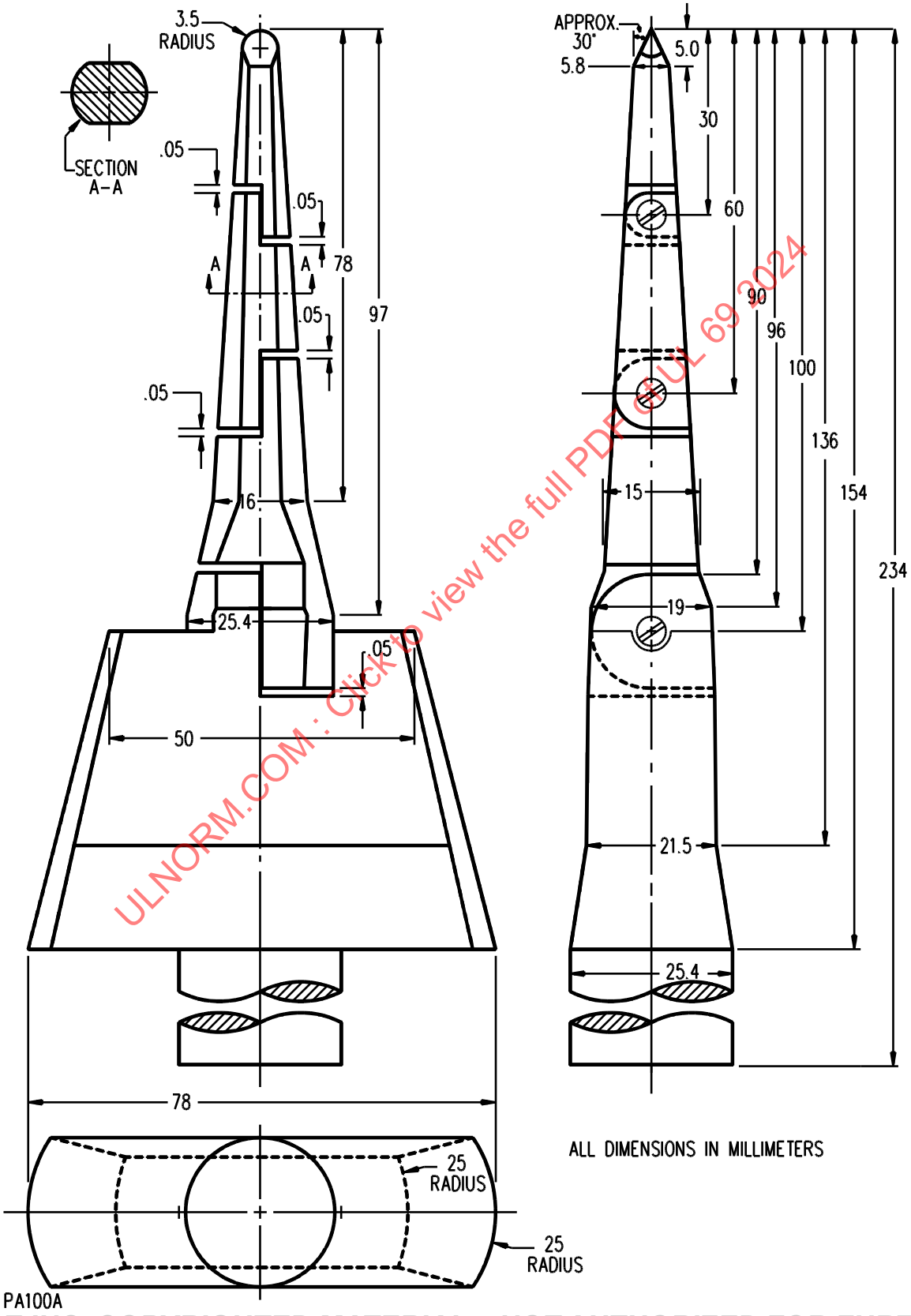


Figure 10.6

Articulate probe with web stop



10.4.9 With reference to 10.4.7, for a direct plug-in controller employing removable blades for the input connectors, the measurement shall also be determined on the plug module while removed from the direct plug-in controller.

10.4.10 The controller shall be provided with the instructions of 40.6.

11 Current-Carrying Parts

11.1 A current-carrying part shall be silver, silver plated, copper, or a copper alloy or other metal acceptable for the application. Plated or stainless steel parts are acceptable for fence terminals.

12 Accessible Parts

12.1 The replacement of a replaceable device that is accessible to the user with a readily available device that is adaptable to the fence controller shall not adversely affect the output characteristics of the fence controller. In addition, the fence controller shall be marked as specified in 38.6.

13 Internal Wiring

13.1 General

13.1.1 All wiring shall be enclosed within the tamper-resistant enclosure.

Exception: Parts as mentioned in 6.1.1 and 6.1.8 need not be enclosed.

13.1.2 A line-operated fence controller shall be provided with a barrier or barriers, or equivalent construction, that will afford separation of the primary and secondary fence circuits.

Exception: If a conductor in the primary circuit cannot be made to contact the fence circuit and a conductor in the fence circuit cannot be made to contact the primary circuit, then a barrier need not be provided.

13.1.3 With regard to the requirements in 13.1.2, a polymeric material is able to be employed for the barrier when it:

a) Is classed V-0, 5VA, or 5VB for flammability,

b) Has a hot-wire-ignition performance level characteristic (PLC) of 4 or lower,

c) Has a high-current-arc ignition PLC of 4 or lower, and

d) Has a comparative Tracking Index PLC of 2 or lower.

When a metallic barrier is provided, it shall be electrically bonded to the equipment grounding means or the output ground terminal, as appropriate.

Exception No. 1: The Comparative Tracking Index (CTI) PLC is able to be 4 or lower, when used in conjunction with a clearance (through air spacing) of at least 0.3 mm between the live part and the barrier.

Exception No. 2: When the fence controller is provided with an equipment grounding means through the supply cord, the metallic barrier shall be electrically connected to the supply cord's equipment grounding means.

13.1.4 With respect to 13.1.3, the flammability class is to be determined by the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and the performance level

characteristics (PLC) are to be determined by the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

13.1.5 A rubber-insulated conductor shall not be exposed to oil, grease, oily vapor, or other substance having a deleterious effect on rubber.

13.1.6 A wireway shall be smooth and free from sharp edges, burrs, fins, moving parts, or the like that might damage insulated conductors.

13.2 Splices and connections

13.2.1 A soldered connection that is located where loosening of the solder is likely to occur, and may result in any grounding or short-circuiting of live parts or in a risk or electric shock, shall be made mechanically secure before soldering.

13.2.2 Each splice and connection shall be mechanically secure and shall provide adequate and reliable electrical contact.

13.2.3 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of spacing between the splice and live parts of opposite polarity and dead-metal parts may not be maintained.

13.2.4 The voltage rating of each primary circuit wire shall be equal to or higher than the voltage involved.

13.2.5 A printed-wiring board used in primary and secondary circuits where loosening of the bond between the conductor and the base material may result in a risk of fire or electric shock shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796.

13.2.6 The securing of components, such as resistors, capacitors, inductors, transformers, and the like, to a printed-wiring board to form a printed-wiring assembly, and the mounting of the assembly itself, shall be such that any forces that might be exerted on the components or board during assembly, shipping or handling of the fence controller or during use or servicing, will not displace the components or deflect the board so as to introduce a risk of fire or electric shock.

14 Insulating Material

14.1 Material for the mounting of live parts shall be porcelain, phenolic composition, cold-molded composition, or similar material that is acceptable for the application. Thermoplastic or thermosetting materials shall comply with the applicable requirements in Polymeric Materials, Section 20.

14.2 Hard fiber may be used for an insulating bushing, washer, separator, and barrier, if shrinkage, current leakage, or warpage will not affect adversely the operation of the fence controller. Fiber is not acceptable for the sole support of uninsulated live parts.

15 Grounding

15.1 An electric fence controller shall be provided with a clearly identified output ground terminal.

15.2 A fence controller that does not have provision for an equipment grounding means through the supply circuit connections and is not double insulated shall have the output ground terminal connected to all exposed dead metal parts of the enclosure, the grounded side of the secondary of the output

transformer, the transformer core, and all metal separating barriers that are required in accordance with 13.1.2 and 18.1.

Exception: A nameplate, a metal corner strip, an ornamental screw, and similar minor exposed dead metal parts mounted on insulating material if completely outside an enclosure housing a live part need not be connected to the output ground terminal.

15.3 A fence controller that has means for equipment grounding provided through the supply circuit by means for connection of a grounding conductor in a splice compartment as specified in 10.2.13 or 10.2.14, or by means of an equipment grounding conductor of a 3-wire power supply cord as specified in 10.3.1.1(a) shall be constructed so that the equipment grounding conductor is connected to all exposed dead metal parts of the enclosure, the transformer core, and all metal separating barriers that are required in accordance with 13.1.2 and 18.1. All portions of the secondary circuit of the output transformer that are intended to be grounded at the installation shall be isolated, as determined by the performance tests of this standard, from the parts grounded through the equipment grounding conductor and connected to the output ground terminal.

Exception: A nameplate, a metal corner strip, an ornamental screw, and similar minor exposed dead metal parts mounted on insulating material if completely outside an enclosure housing a live part need not be connected to the output ground terminal or the equipment grounding means.

15.4 A fence controller that has a means for connection of an equipment grounding conductor as specified in 15.3 shall comply with the marking requirements in 39.4.1, and the installation and operation instruction requirements in 40.2.

15.5 A fence controller that is double-insulated in accordance with 10.3.1.1(b) shall be provided with an output ground terminal that is isolated from all parts of the controller that are protected by the double insulation system. All portions of the secondary circuit of the output transformer that are intended to be grounded at the installation shall be connected to the output ground terminal.

16 Motors

16.1 A motor provided as a part of a fence controller shall be acceptable for the application.

16.2 A motor winding shall be such as to resist the absorption of moisture.

16.3 Film-coated wire or wire employing cotton over enamel is not required to be additionally treated to reduce the likelihood of moisture absorption.

16.4 If the stalling of a motor would be likely to result in a risk of injury, the motor bearings shall be of a type that require no lubrication or the controller shall be provided with some feature that will reduce the likelihood of such stalling.

16.5 If the motor speed can be controlled, the motor-control switch or rheostat shall be connected so that any variation of the motor speed will not adversely affect the performance of the fence controller with respect to the requirements specified in Output Characteristics Test, Section 22, for the minimum off-period and the maximum allowable output and time duration for the on-period.

16.6 A brush-holder assembly shall be constructed so that when a brush is worn out – no longer capable of performing its function – the brush, spring and other parts of the assembly are retained to the degree necessary not to cause accessible dead-metal parts to become energized and live parts to become accessible.

17 Protective Devices

17.1 Overload protection

17.1.1 A fence controller shall be provided with a protective device that shall be located in the primary circuit of the controller or shall be such as to preclude any voltage surge that would be likely to affect the insulation of the fence controller and any condition that would be likely to contribute to the creation of a risk of fire or electric shock.

17.1.2 The overload protection shall provide on- and off-periods that comply with those specified in 22.1.1.

17.1.3 A capacitor connected across the contacts of a make-and-break protective device is considered as complying with the requirements in 17.1.1, provided the measured value of effective current at the output (fence) terminals is not more than 0.5 mA when the contacts of the interrupting means are open.

17.2 Overcurrent protection

17.2.1 A fence controller shall be provided with a fuse or equivalent overcurrent protection.

17.2.2 The fuse or equivalent overcurrent protection in a line-operated fence controller shall be rated not more than 1 A, and shall be provided in both conductors of the primary circuit.

Exception: A fence controller that is provided with double insulation may be provided with a fuse or equivalent overcurrent protection in one of the conductors of the primary circuit only.

17.2.3 A fence controller that employs fuses as the required overcurrent protection in the primary circuit of a fence controller shall be marked as specified in 38.5.

17.2.4 An automatic overcurrent-protective device shall be such that it cannot be blocked in the on-position.

17.2.5 A battery-operated fence controller is required to be provided with a fuse or equivalent overcurrent protection.

17.3 Overvoltage suppressors

17.3.1 An overvoltage suppressor shall be acceptable for the application.

17.3.2 An overvoltage suppressor in the primary circuit of a line-operated fence controller that does not have the spacings that are specified in 19.1 and Table 19.1 for other portions of the circuit shall be connected on the load side of a fuse or equivalent protective device.

17.4 Transient voltage surge suppressors

17.4.1 A transient voltage surge suppressor electrically connected on the supply side of a line-connected electric-fence controller shall comply with the duty cycle test program in the Standard for Surge Protective Devices, UL 1449.

17.5 Software

17.5.1 Circuits that rely on software alone to comply with the output limits of Sections 22 and 23 shall comply with UL 60335-1 Annex R (Household appliance software evaluation). References to "clause

19.13 of IEC 60335-1" shall be replaced with "the output limits of Sections 22 and 23 " and references to "19.11.2 of IEC 60335-1" shall be replaced with "Section 23.2 ." The software shall be evaluated for Class C compliance.

Note: In IEC 60335-1, Ed. 5.0, the term "Class C" has changed to "Table R.2." These two terms have the same meaning.

18 Transformers

18.1 A transformer employed in a line-operated fence controller shall have the primary winding permanently and reliably isolated from all other circuits, so that electrical breakdown within the transformer will not result in a risk of fire or electric shock on the fence. See 18.2.

18.2 To comply with the requirements in 18.1, a transformer shall comply with the requirements in the Burnout Test, Section 31, and one of the following, as applicable:

a) Windings shall be wound on separate bobbins of acceptable insulating material on separate legs of the core of the transformer. The bobbins shall be reliably separated by a barrier, see 13.1.2, that extends a minimum of 1/4 in (6.4 mm) beyond the radius of the coils.

b) Primary and fence windings, or adjacent secondary windings, shall be wound on one length of an insulated core (both coils on the core, not concentric) if the two windings are separated end to end by a barrier as described in 13.1.2. The barrier shall extend a minimum of 1/4 in beyond the radius of the coils.

c) Concentrically wound primary and fence windings or fence winding and adjacent secondary windings shall be separated by a grounded-copper shield. The shield shall be at least 0.005 in (0.13 mm) thick and extend a minimum width of 0.010 in (0.25 mm) on either side of the primary winding edge. The copper shield shall overlap a minimum of 1/4 in and contain primary winding splices and crossover leads, if present.

d) Concentrically wound primary and secondary windings, or adjacent secondary windings, shall be provided with overtemperature protection, such as inherent impedance protection as determined by the Burnout Test, Section 31, or a thermal fuse, and shall be separated by three layers of insulating material. Any combination of two layers of the insulation shall withstand a 3500-V, 60 Hz potential for 1 min without electrical breakdown. The insulating material – type, combination and thickness – shall also be provided for the splices and crossover leads.

e) A construction that provides equivalent isolation between primary windings and other circuits.

18.3 A coil shall be wound in an acceptable manner and shall have acceptable, adequate insulation between any two windings, and between each winding and the core and enclosure.

18.4 Each coil shall be treated with an insulating varnish or otherwise impregnated to exclude moisture.

19 Spacings

19.1 The spacing between uninsulated live parts of opposite polarity, and between an uninsulated live part and a dead metal part shall not be less than the value specified in Table 19.1. If a live part is not rigidly supported, or if a movable part is in proximity to a live part, the construction shall be such that these minimum or larger spacings will be maintained.

Exception: The spacings may be less than specified in Table 19.1 if in compliance with the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

Table 19.1
Spacings

Parts involved[a]	Minimum spacings, in (mm)							
	Power-operated fence controllers				Battery-operated fence controllers			
	Through air		Over surface		Through air		Over surface	
Between wiring terminals	1/2	(12.7)	1/2	(12.7)	1/4	(6.4)	1/4	(6.4)
Between a wiring terminal and dead-metal parts	1/4	(6.4)	3/8	(9.5)	1/4	(6.4)	3/8	(9.5)
Between parts of opposite polarity in the primary circuit and between any such live part and dead metal parts except at wiring terminals and at lightning arresters	1/8	(3.2)	1/4	(6.4)	–		–	

[a] See 19.3.

19.2 With respect to the Exception to 19.1:

a) If a fence controller employs a voltage limiting device for application of the requirements in UL 840, the device shall comply with the Standard for Surge Protective Devices, UL 1449.

b) The internal micro-environment of the enclosure housing the timing and output mechanism shall be considered pollution degree 3 (that is an environment that has conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation that is expected) as defined in UL 840.

c) Permanently connected fence controllers shall be considered overvoltage category 3, and cord-connected fence controllers with surge suppressors shall be considered overvoltage category 2. An overvoltage category is the grouping of products based on a typical installed location with respect to overvoltage protection and available energy as defined in UL 840.

19.3 Wiring terminals are terminals to which supply connections are to be made in the field.

20 Polymeric Materials

20.1 A polymeric material, thermoplastic or thermosetting, used to provide all or part of the enclosure for electrical parts as specified in 6.1.1, or used to provide structural support of live parts as specified in 19.1, shall comply with the requirements in this section.

20.2 Reference is made in 20.3 – 20.9 to the following standards:

a) Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, and

b) Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

20.3 A material shall comply with the requirements specified in UL 746C, and with the requirements in 20.4 – 20.9.

20.4 With respect to consideration of thermal endurance in accordance with UL 746C, a normal temperature test shall be conducted. If enclosure temperatures exceed 65°C (150°F), the material shall have:

a) A mechanical temperature index, determined with respect to impact, and long-term aging, of at least the measured temperature; and

b) An electrical temperature index, determined with respect to long-term aging, of at least the measured temperature if the part is involved in the direct or indirect support of a live part.

Exception: A material may be acceptable for temperatures over 65°C without testing to determine long-term thermal aging characteristics if it has been found acceptable for higher temperatures as a generic material class in accordance with UL 746B.

20.5 The investigation in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, shall include the ball-impact test. The drop test shall also be conducted for a portable fence controller.

20.6 The mold stress-relief distortion testing specified in UL 746C shall be conducted only by the air-oven method, not by the test cell method.

20.7 The severe-conditions and abnormal operation tests in UL 746C are not to be conducted.

20.8 All metal parts in a polymeric enclosure that are required to be grounded shall be bonded in accordance with the requirements in Grounding, Section 15.

20.9 A material used for the direct or indirect support of live parts, as defined in UL 746C, shall comply with the requirements in UL 746C.

Exception: Materials that may not have acceptable properties as tabulated in UL 746C may be tested in the application in accordance with UL 746C.

PERFORMANCE

21 General

21.1 All electrical tests are to be conducted with the fence controller connected to:

a) A battery for which the product is rated, or a power supply that is equal to the rated battery-terminal voltage plus 5 percent for a battery-operated product; or

b) A power supply that is equal to the maximum rated voltage and frequency of the product for a line-operated product, but not less than 120 V.

21.2 All voltages and current values specified are rms values unless otherwise noted.

21.3 In general, the voltage in other than the primary supply circuit is to be measured using a voltmeter or voltmeter-multiplier combination having a resistance of not less than 10,000 Ω/V. Meters having higher input impedances are to be employed if necessitated by the impedance of the circuit under test.

21.4 When determining the values of voltage across the output-load resistance – see Section 22, Output Characteristics Test – an oscilloscope is to be used. The input impedance of the probe is to be at least 10 MΩ. The oscilloscope and probe are to have less than a 3 decibel loss in amplitude compared to midband performance at 3 MHz. The oscilloscope is to have either storage or photographic capability in order to capture a single pulse output waveform.

21.5 When measuring the duration of various output characteristics, the duration is considered to be continuous from the initial time of exceeding the critical value, until the absolute value of current for the output falls below the critical value and remains below the critical value for at least 400 µs. See 22.1.1(b).

21.6 The cloth used for the tests is to be bleached cheesecloth running 14 – 15 yd^2/lb (26 – 28 m^2/kg) and having what is known in the trade as a count of 32 by 28; that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 threads in the other direction).

22 Output Characteristics Test

22.1 General

22.1.1 When operated under any arrangements of control settings or tap selections available, and in any position of orientation, a fence controller shall comply with all of the following:

a) The rms value of each current pulse or pulse segment from each pair of output terminals connected in turn to a noninductive resistor not less than 500 Ω in parallel with a capacitor between 0 and 2 µF, adjusted to produce the maximum output, shall not exceed the limit of Figure 22.1. Pulse current is to be calculated as follows:

$$I - 20T^{-0.7}$$

where:

I = rms pulse current (mA), and

T = pulse time (s)

In the event there is a difference between the limit determined by Figure 22.1 and the calculation above, the calculation will serve as the referee for determining compliance.

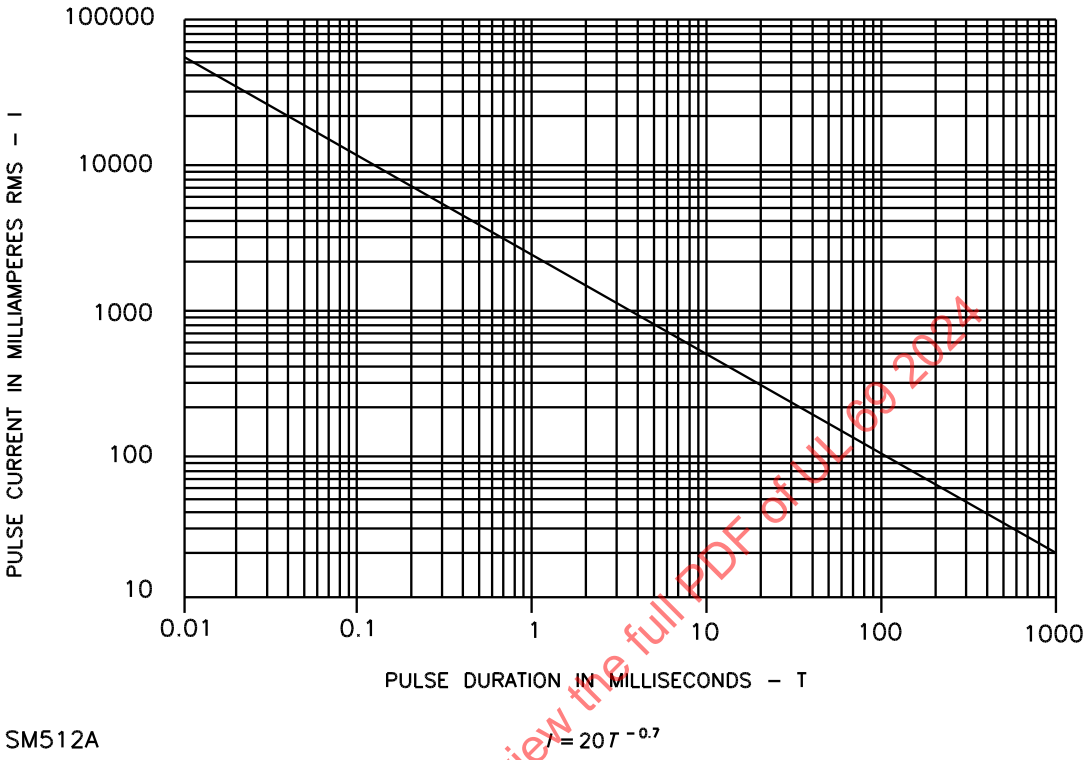
b) The current pulses shall be separated from each other by off intervals that are at least 1 s (continuous) in duration. During the off intervals, the absolute value of the instantaneous current shall not exceed 7 mA. (The total period of the cycle is the sum of the current pulse duration plus an interval after the pulse during which the instantaneous current falls to 7 mA or less plus the duration of the off interval.)

c) The peak of any transient current associated with the output shall be of such a nature that the elapsed time between the increasing and diminishing currents, measured at a 300 mA value, is not more than 1.5 ms.

22.1.2 The output of a fence controller shall be a series of pulses separated from each other by off intervals. Each pulse may be unidirectional or oscillatory. A fence controller shall not have a continuous (uninterrupted) output. The maximum on time shall not exceed 1 s.

Figure 22.1

Current (mA) verses time (ms)



22.1.3 A minimum of ten randomly selected current pulses shall be measured. All shall comply with the limits specified in 22.1.1(a). Current pulses that are not simple unidirectional pulses or decaying oscillatory current waveforms shall be the subject of a special investigation to determine acceptability.

22.1.4 In any test involving a load on a fence controller, the load on the output circuit is to be varied from the specified minimum value of resistance and within the specified range of capacitance to produce the maximum output or the minimum off-period of the fence controller. The impedance of the measuring devices connected to the load are to be considered part of the load.

22.2 Operating position

22.2.1 The output characteristics of a fence controller shall comply with the requirements in Figure 22.1 and 22.1.1 regardless of the position in which it is operated.

22.3 Voltage range

22.3.1 A fence controller shall be operated on a supply circuit as described in 22.3.2 and 22.3.3. The duration of the on-period and the off-period shall comply with the requirements in 22.1.1.

22.3.2 A fence controller is considered to comply with the requirement in 22.3.1 if it has features that render it inoperable to the extent that the magnitude of the current and the duration of the on-period of the current on the fence do not result in a risk of fire or electric shock when the fence controller is operated from a supply circuit of any voltage less than the rated primary voltage of the fence controller.

22.3.3 To determine whether a fence controller complies with the requirement in 22.3.1, it is to be operated at various primary voltages within the applicable range specified in Table 22.1. For a battery-operated fence controller, the battery potential specified is the open circuit voltage of the battery, and the fence controller is to be tested under both conditions of battery polarity.

Table 22.1
Primary voltage for range test

Rated voltage	Applied voltage
Power operated controller:	
Less than 100 V	Rated voltage ±10 V
100 – 125 V	105 – 125 V
Battery operated controller:	
6 V	3 – 6.6 V
12 V	6 – 13.2 V

22.3.4 The off-period of a battery-operated fence controller shall be at least 1 s when operated at a primary voltage of less than 3 V for a fence controller having a rating of 6 V, and at a primary voltage of less than 6 V for a fence controller having a rating of 12 V.

23 Abnormal Operation Test

23.1 Pilot lights

23.1.1 An open circuit or a short circuit at the lampholder of a pilot light or other indicating light that is accessible from outside the tamper-resistant enclosure shall not adversely affect the output characteristics of the fence controller.

23.2 Components

23.2.1 The short- or open-circuiting of a component, other than a transformer, in the timing or output circuits of a fence controller, or external triggering of a semiconductor device as indicated in 23.2.4 shall not result in a risk of fire or electric shock. See 23.2.2. The abnormal conditions are to be as specified in Table 23.1 and 23.2.7.

Table 23.1
Abnormal conditions

Component	Short-circuit	Open-circuit
Capacitors	X	X
Inductors	X	X
Relays	X	X
Resistors:		
Carbon	X	X
Wire or helically wrapped[a]		X
Semiconductor devices	X	X
Switches	X	X

[a] Wire wound, metal film, metal glazed, and carbon film.

23.2.2 A risk of fire during abnormal conditions is considered to exist if the cheesecloth or tissue paper specified in 23.2.7 glows or ignites. A risk of electric shock during abnormal conditions is considered to exist if the output characteristics do not comply with 22.1.1, or if the fence controller does not comply with 23.2.3.

23.2.3 If the off interval between current pulses decreases to less than 0.75 s under the conditions specified in 22.1.1, the limits in Figure 22.1 no longer apply and the fence controller shall interrupt the output within 3 min. The resetting of an operator accessible device or the replacement of an operator accessible fuse of any value as permitted by the construction of the fuseholder shall not permit operation of the fence controller.

Exception: Interruption of the output is not required if the absolute value of the instantaneous current of the current pulse or pulse segment during or after the abnormal test does not exceed 7.0 mA peak.

23.2.4 When a semiconductor device is subjected to external triggering as specified in 23.2.5 and 23.2.6, the fence controller shall comply with 23.2.1 and 23.2.3.

Exception: A fence controller need not comply with 23.2.3 if the output characteristics of a fence controller, when subjected to the requirements specified in 23.2.5 and 23.2.6, is equal to or less than the values specified in Figure 23.1. Semiconductor pulse current is to be calculated as follows:

$$I - 20T^{-0.7}\ (PRF^{-0.5})$$

where:

I = rms of half-wave of the pulse (mA),

T = pulse duration (s), and

PRF = pulse repetition frequency

In the event there is a difference between the limit determined by Figure 23.1 and the calculation above, the calculation will serve as the referee for determining compliance.

23.2.5 The semiconductor switching network controlling the output pulse is to be subjected to an external independent triggering test to produce an output pulse repetition frequency (PRF) of 1, 2, 3, 5, 10, 20, 60, and 120 Hz. A separate test as specified in 23.2.6 is to be conducted for each output pulse rate.

23.2.6 Each test as specified in 23.2.5, is to begin by operating the unit for 1 min under the load condition specified in 22.1.4 at normal output operating frequency. The semiconductor switching network controlling the output pulse is to be externally triggered to produce the required output pulse rate within 10 s. The unit is then to be operated for 3 min at the required output pulse rate. Output characteristic measurements are to be taken after the three minute interval. The unit is to cool to room temperature between each test.

23.2.7 In conducting the test, a single layer of cheesecloth is to be loosely draped over the fence controller as a whole with the controller placed on a white-tissue covered softwood surface. The controller is to be connected to a supply circuit of rated voltage and frequency and operated until:

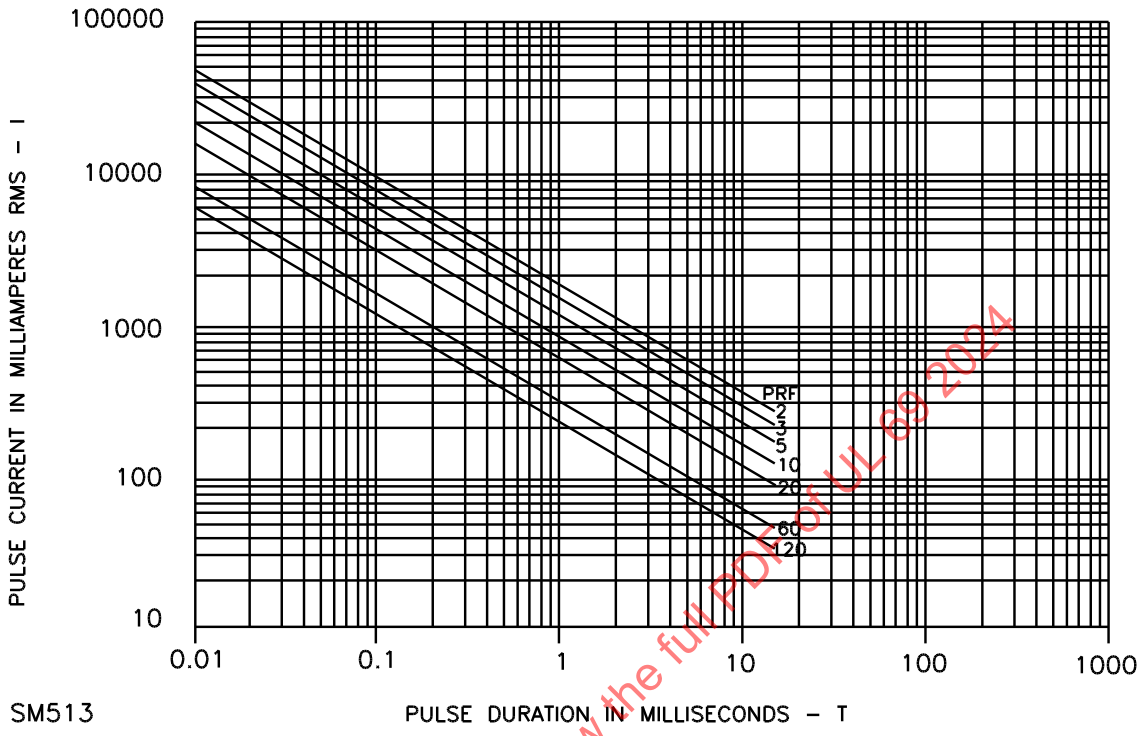
a) The cheesecloth or tissue paper glows or ignites,

b) The circuit or a component in the circuit (including an overcurrent-protective device) has opened, or

c) No further change takes place, but in no case is the test to be continued for more than 7 h.

Figure 23.1

Pulse current limits for semiconductor abnormal operation



$I = 20T^{0.7} (PRF^{-0.5})$

See 22.1.1

23.3 Live parts

23.3.1 The continuous current available at an accessible live part – other than a primary terminal, lampholder or fuse, or any circuit operating at 12 V or less – such as a vacuum-tube-socket contact or the like, that may be employed in energizing a fence, and the continuous valve of effective current available on the fence as the result of tampering with such a live part, shall not be more than 5 mA dc, rms, sinusoidal, or 7.07 mA peak when measured through a noninductive resistance of 500 Ω to ground or to the ground terminal of the fence controller; or the live part in question shall comply with the requirements in 12.1 and 17.1 with respect to maximum current and current interruption.

24 Leakage Current Test

24.1 The leakage current of a portable line-operated controller when tested in accordance with 24.2 – 24.8 shall not be more than 0.5 mA ac rms.

24.2 Leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces of a controller and ground or other exposed conductive surfaces of a controller.

24.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. A part is considered to be an exposed surface unless guarded by an enclosure that complies with the requirements in Section 6, Enclosure. Surfaces are considered to be simultaneously accessible when they

can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at extra low voltages that are not considered to involve a risk of electric shock or to ungrounded output terminals for connection to the fence.

24.4 If a surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 10 by 20 cm in contact with the surface. Where the surface is less than 10 by 20 cm, 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 controller.

24.5 The measurement circuit shall be as illustrated in Figure 24.1. The measurement instrument is defined in items (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

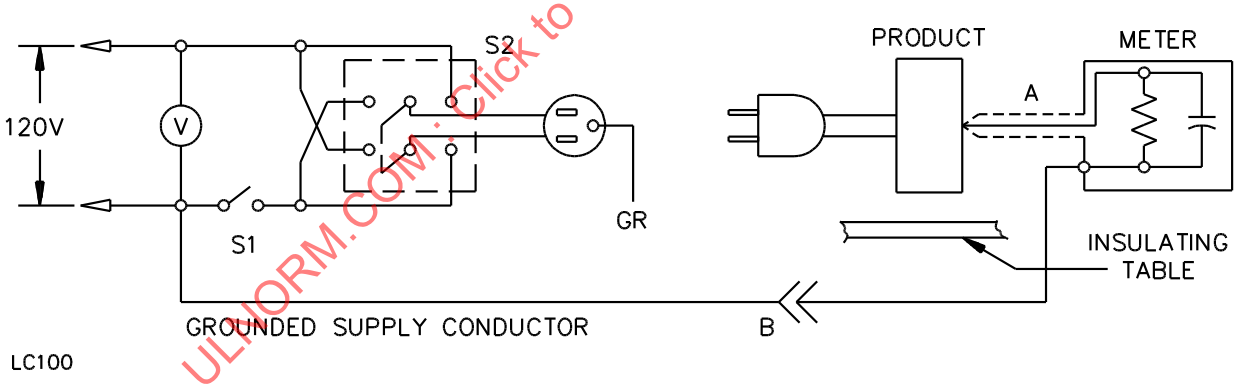
a) The meter is to have an input impedance of 1500 Ω resistive shunted by a capacitance of 0.15 μF.

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-Ω resistor shunted by a 0.15-μF capacitor to 1500 Ω. At an indication of 0.5 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.

Figure 24.1

Leakage current measurement circuits



NOTES –

A – Probe with shielded lead.

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

24.6 The meter is to be connected to the accessible part that is connected to the grounding pin of an attachment plug cap or the output ground terminal, and the grounded supply conductor.

24.7 The sample is to be at room temperature at the start of the test. It is to be energized and operated under conditions of normal load described in Section 26, Temperature Test, until thermal stabilization is attained. Before, during and after this operation, the leakage current is to be monitored. A controller with controls is to be tested with such controls in all of their various operating positions. For the test, the leakage current is to be noted using both positions of switch S2 and with switch S1 both open and closed.

24.8 During the test, a controller employing a grounded type attachment plug cap is to have the grounding connection open at the attachment plug cap. The output ground terminal is not to be connected to ground. The controller is to be placed on an insulating (not grounded) surface.

25 Leakage-Current Test Following Humidity Conditioning

25.1 A portable line-operated controller shall comply with the requirements for leakage current specified in 24.1, following the conditioning described in 28.1.2.

a) The controller is to be at a temperature just above the test chamber temperature when it is placed in the humidity chamber;

b) The controller is to remain in the humidity chamber for 48 h;

c) Following this exposure, while still in the test chamber, the sample is to be tested unenergized (that is, switch, S1, open); and

d) The sample is then to be tested energized, except that the test may be discontinued when the leakage current has stabilized or decreased. This test condition may be conducted in the humidity chamber or immediately after the sample has been removed from the humidity chamber.

26 Temperature Test

26.1 A fence controller shall be tested as described in 26.2 and 26.3, and shall not reach a temperature at any point high enough to result in a risk of fire, to damage any materials in the fence controller, or to exceed the temperature rises specified in Table 26.1.

Table 26.1
Maximum acceptable temperature rises

Materials and components	°C	°F
Capacitor	The marked temperature limit of capacitor[a]	
Class A insulation	65	117
Class B insulation	85	153
Fuses[b]	65	117
Fiber employed as electrical insulation	65	117
Phenolic composition employed as electrical insulation	125	225
Rubber- or thermoplastic-insulated wires	35	63
Sealing compound	15°C (27°F) less than melting point[a]	
Varnished-cloth-insulated wires	60	108

[a] These are maximum temperatures and not temperature rises.

[b] When measuring the temperature rise of a fuse inserted in an extractor cap fuseholder, the temperature of the rear terminal of the fuseholder is to be measured.

26.2 To determine whether a fence controller complies with the requirement in 26.1, the fence controller is to be operated with the secondary loaded as described in 22.1.4, and with the primary connected to a

supply circuit of rated frequency. For a line-operated controller the potential of the supply circuit is to be 125 V.

26.3 Temperature readings are to be obtained by means of thermocouples. Thermocouples are to consist of 28 – 32 AWG (0.08 – 0.032 mm^2) iron and constantan wires.

26.4 A temperature is considered to be constant when three successive readings, taken at 5 min intervals, indicate less than 1°C (1.8°F) change.

27 Dielectric Voltage-Withstand Test

27.1 A line-operated fence controller shall withstand, without breakdown, for 1 min the application of a 60 Hz essentially sinusoidal potential:

a) Between the primary circuit and the enclosure, and

b) Between the primary circuit and the grounding means.

The effective value of the test potential is not to be less than 1500 V rms (2120 V dc) or equivalent. All primary circuit surge suppressors may be disconnected during this test.

27.2 To determine if a fence controller complies with the requirements in 27.1, the test is to be made immediately after the fence controller has been conditioned for 4 h at a temperature of 57 ±2°C (126 ±4°F) in accordance with 22.3.1. The test potential is to be applied with any voltage-limiting devices disconnected. The test is to be conducted using a testing transformer having an output voltage that is essentially sinusoidal and can be varied. Starting at zero, the applied potential is to be increased gradually until the required test value is reached or until breakdown occurs.

27.3 The insulation and spacings in a fence controller shall be such that there will be no arcing or flashover when it is operated while connected to a supply circuit having a potential of any value not greater than 150 percent of the rated primary voltage of the fence controller.

27.4 To determine whether a fence controller complies with the requirement in 27.3, it is to be operated for 1 min under conditions of maximum secondary voltage while connected to a supply circuit having a potential of any value not greater than 150 percent of the rated primary voltage of the fence controller. During the test, any secondary arc-gap or lightning arrester – including fence terminals intended to provide similar protection – is to be disconnected.

28 Humidity and Water-Spray Test

28.1 Humidity

28.1.1 A fence controller shall be conditioned as specified in 28.1.2. After the conditioning, the output characteristics of the fence controller shall comply with the requirements in 22.1.1, Section 25, Leakage Current Test After Humidity Conditioning, and Section 27, the Dielectric Voltage-Withstand Test.

28.1.2 A fence controller is to be conditioned for 48 h in a moist atmosphere having a relative humidity of 90 ±5 percent and a temperature of 30 ±2°C (86 ±4°F).

28.2 Water-spray

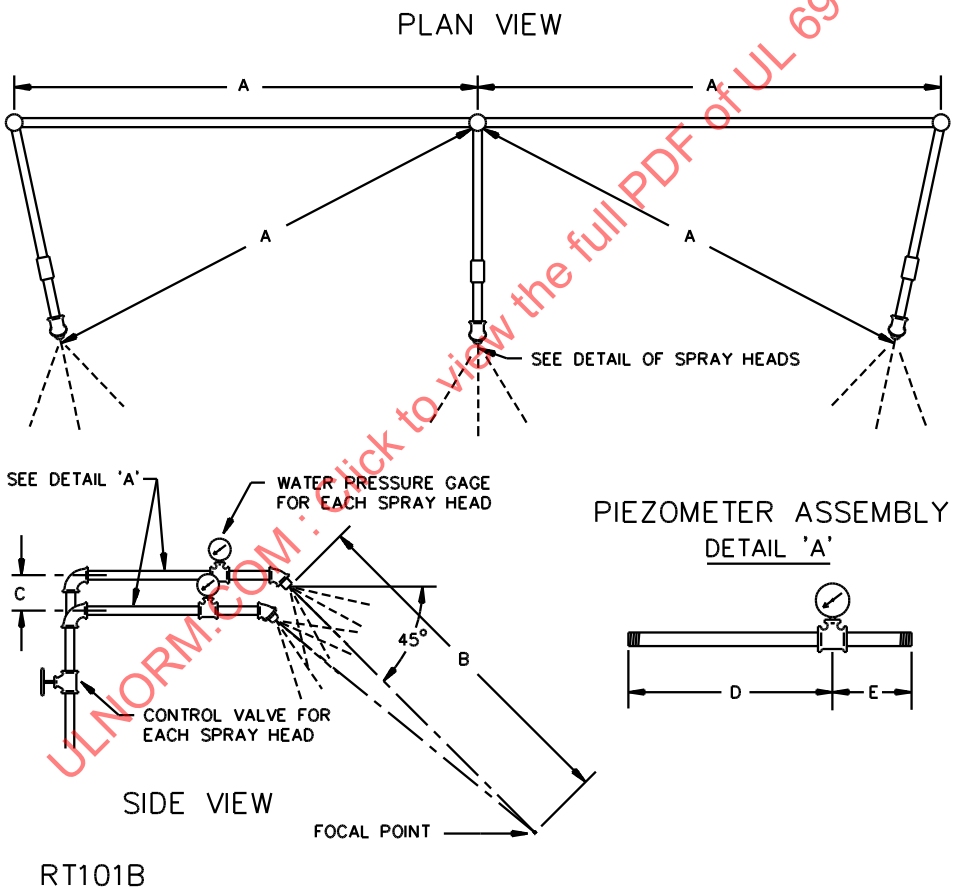
28.2.1 Following the conditioning and testing described in 28.1.1 and 28.1.2, a fence controller marked for outdoor use is to be conditioned as specified in 28.2.2. Following the application of the water spray, the fence controller shall comply with the requirements in 22.1, and the Dielectric Voltage-Withstand Test,

Section 27. There shall be no visible evidence of wetting of uninsulated live parts, except for output terminals.

28.2.2 For the conditioning specified in 28.2.1, the fence controller is to be mounted as in intended use, and subjected to a water spray for 2 h. While being subjected to the water spray, the fence controller is to be allowed to operate for the first hour, and then is to remain inoperative for the second hour. The water-spray-test apparatus is to consist of three spray heads mounted in a water-supply pipe rack as illustrated in Figure 28.1. Spray heads are to be constructed in accordance with the details illustrated in Figure 28.2. The water pressure for all tests is to be maintained at 5 psi (34.5 kPa) at each spray head. The distance between the center nozzle and the fence controller is to be approximately 5 ft (1.5 m). The spray is to be directed at an angle of 45 degrees to the nearest current-carrying parts.

Figure 28.1

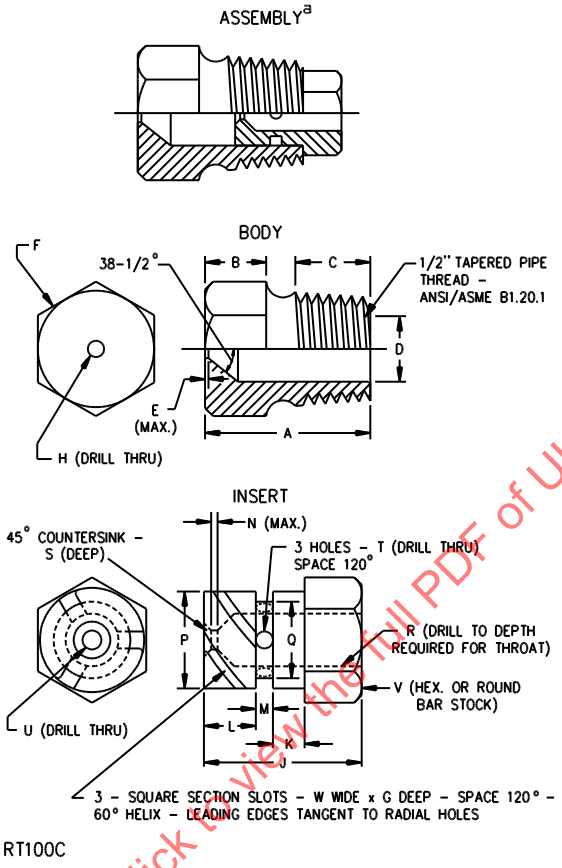
Spray head pipe rack



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

Figure 28.2

Spray head assembly



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

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

[b] ANSI B94.11M Drill Size

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

29 Hosedown Test

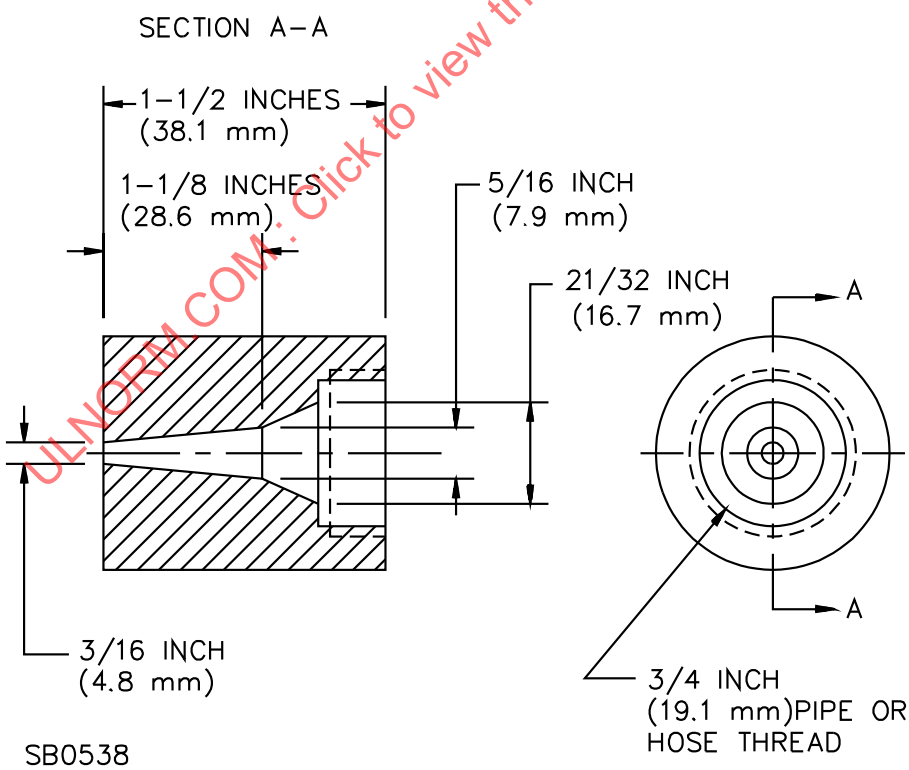
29.1 A fence controller is to be conditioned as specified in 29.2 and 29.3. After the conditioning, a fence controller shall comply with the requirements in 22.1.1 for output characteristics, and the Dielectric Voltage-Withstand Test, Section 27. There shall be no visible evidence of wetting of uninsulated live parts, except for output terminals.

29.2 During the test specified in 29.3, a conduit may be installed on the enclosure of a permanently mounted controller to equalize internal and external pressures so as not to artificially draw water into the enclosure, but is not to serve as a drain. No sealing compound other than that normally provided by the manufacturer is to be used.

29.3 For the conditioning required in 29.1, a fence controller is to be mounted as in intended use at the height specified by the manufacturer or, if not specified, at a height of 5 ft (1.5 m). The enclosure of a fence controller and its external mechanisms are to be sprayed by water from a hose fitted with a nozzle as illustrated in Figure 29.1. The flow rate of the hose is to be at least 5 gal (19 L) of water per min. The water stream is to be directed at the joints of the enclosure from a distance of 10 – 12 ft (3.0 – 3.7 m) and is to be moved along the joints or surface at a minimum rate of 4 s per linear in (1.6 s/cm). The total duration of the water stream contact with the fence controller enclosure is to be 5 min. At the conclusion of the water spray, the exterior of the fence controller is to be wiped dry.

Figure 29.1

Nozzle



30 Impact Test

30.1 A fence controller is to be tested as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, regardless of the material employed for the enclosure. A permanently connected controller is to be subjected to the ball impact test specified in UL 746C. A

portable controller is to be subjected to the ball impact specified in UL 746C, and the drop test specified in 30.3. As a result of the test or tests:

a) A fence controller employing a polymeric enclosure shall comply with the acceptance criteria of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

b) A fence controller employing an enclosure of other than a polymeric material shall not be adversely affected by the impacts, and there shall be no increase in the risk of fire, electric shock, or injury to persons, from conditions such as a reduction of electrical spacings.

c) The output characteristics shall not be appreciably affected, as determined by subjecting one sample of a fence controller that has been subjected to the impacts required in 30.1 to the Output Characteristics Test, Section 22. A fence controller is considered to comply with this requirement if it becomes inoperable, or if the variation in output characteristics is such that no risk of fire, electric shock, or injury to persons will result.

30.2 A fence controller intended to enclose a battery or batteries is to be tested with the battery or batteries installed in their intended location and manner within the enclosure.

30.3 Each of the three samples is to be dropped three times onto a concrete surface from a height of 3 ft (0.92 m). The side of the enclosure that is intended to face the wall after installation is not exempt from this test.

31 Burnout Test

31.1 A fence controller shall not create a risk of fire and shall not emit flame or molten metal when operated continuously until constant temperatures are attained or until burnout occurs, under load conditions that result in the maximum input to the fence controller, and with the current-interrupting means locked in the on-position.

31.2 To determine whether a fence controller complies with the requirement in 31.1, the fence controller is to be operated from a circuit of rated voltage and frequency and with control switches, if any, set for the maximum current in the secondary circuit.

31.3 A single layer of cheesecloth is to be loosely draped over the fence controller. The fence controller is to be placed on a white tissue covered softwood surface. A risk of fire is considered to exist if the cheesecloth or tissue paper glows or ignites.

31.4 After 7 h, the fence controller is to be disconnected from the supply circuit and a test potential of 1200 V is to be applied between the primary and secondary of the output transformer. There shall be no indication of electrical breakdown.

32 Ignition Tests

32.1 General

32.1.1 The output characteristics of a fence controller shall be such that no condition of grounding resulting in possible arcing between the fence conductor and the grounding means will ignite surgical cotton, cloth, or similar material that may be in contact with the fence conductor.

32.2 Cloth ignition

32.2.1 The test apparatus is to consist of a 6 in (152 mm) square aluminum plate and a length of 12 AWG (3.3 mm^2) solid copper conductor cut so that the cut end is shaped as a point to serve as a movable

electrode. The output ground terminal of the fence controller is to be conductively connected to the plate and the fence terminal is to be conductively connected to the movable electrode. Cloth employed as test material is to be in individual pieces with a maximum dimension not exceeding 3/8 in (9.5 mm). The test material is to be dried in an air-circulating oven at 70 ±5°C (158 ±9°F) for 30 min to 1 h. Within 15 min after drying, a volume of approximately 25 mL of the cloth pieces are to be deposited in a cone-shaped pile centered on the plate. The fence controller is to be connected to a power-supply circuit as described in 21.1. Attempts are then to be made to draw an arc between the movable electrode and the plate through, around, and over the cloth pieces. The test is to continue for at least 5 min. There shall be no ignition of the cloth pieces. Displaced pieces may be regrouped once per minute if necessary.

32.3 Surgical cotton ignition

32.3.1 The test apparatus is to consist of a piece of softwood at least 6 in (152 mm) long. A 12 AWG (3.3 mm^2) solid copper conductor is to be inserted at least 4 in (102 mm) into a 3/32-in (2.1-mm) diameter hole drilled 1/4 in (6.4 mm) from the centerline of the hole to the test surface. A separate length of 12 AWG solid copper conductor that has been cut so that the cut end is shaped as a point is to serve as an electrode. The wood with conductor is to be soaked for 15 min in a saline solution consisting of 8 g of table salt per liter of water. The wood is then to be removed and its surface is to be dried such that when blotted no moisture is transferred to the blotter. A 1/4 in layer of surgical cotton that is loose and unstretched is then to be draped over the wood. The conductor from the wood is to be conductively connected to the grounding terminal, and the pointed-electrode conductor is to be conductively connected to the fence terminals. The fence controller is to be connected to a power supply as described in 21.1. Attempts are to be made to draw an arc between the test surface of the wood and the electrode at the fringes of the cotton for 5 min. There shall be no ignition of the cotton. The electrode shall be kept at least 2 in (51 mm) from either end of the piece of wood.

33 Endurance Test

33.1 A fence controller that does not employ a mechanical-timing or -output mechanism shall be operated for a total of 40 days as specified in 33.2, 33.5, and 33.7. Variations in the output characteristics including on-period, off-period, maximum output when connected to a load as specified in 33.8 shall be noted at 7-day intervals throughout the test. The output characteristics shall comply with 22.1.

33.2 A fence controller as specified in 33.1, is to be operated continuously for 20 days (480 h) at an ambient temperature of minus 15 ±2°C (5 ±4°F), and then for 20 days at an ambient temperature of 50 ±2°C (122 ±4°F) degrees. The secondary output terminals are to be connected through a 0.015 µF capacitor during the first 10 days of each 20-day period, and the load is to be removed for the remainder of these periods.

33.3 A fence controller that employs a mechanical-timing or mechanical-output device is to be operated continuously for 6 months as specified in 33.4 – 33.7 while being supported on a softwood surface covered with a double layer of white tissue paper. During the test, there shall be no electrical or mechanical malfunction of the fence controller, and mechanical parts, examined at the conclusion of the test, shall not show undue mechanical wear. There shall be no emission of flame or molten metal, the ground fuse specified in 33.5 shall not open, and the tissue paper shall not glow or ignite. Variations in the output characteristics, including on-period, off-period, and maximum output, when connected to a load as specified in 33.8, are to be noted at one month intervals throughout the test. The output characteristics shall comply with 22.1. The Leakage Current Test, Section 24, is then to be repeated.

33.4 For a fence controller that employs mechanical devices as described in 33.3, during the first 15 days of the endurance test, the secondary circuit is to remain open. During the remainder of the test, the secondary terminals are to be connected through a 0.015 µF capacitor.

33.5 If an equipment grounding means is provided it is to be interrupted. A separate connection through a 1 A fuse is to be made between parts intended to be grounded and ground.

33.6 A fence controller that employs a spark gap device or a surge suppressor, including a metal oxide varistor (MOV), that operates during the normal function of a fence controller is to be subjected to the test specified in 33.3.

33.7 A fence controller is to be operated from a supply circuit in accordance with 21.1.

33.8 At the intervals specified in 33.1 and 33.3, the 0.015 µF load specified in 33.2 and 33.4 is to be disconnected and the load specified in 22.1.4 is to be connected for output characteristics measurements.

34 Strain-Relief Test

34.1 The strain-relief means provided for flexible cord of a fence controller, as specified in 10.3.2.1, shall be tested as described in 34.2. There shall be no indication of more than 1/16 in (1.6 mm) movement of the cord immediately after removal of the force and no indication of more than 1/32 in (0.8 mm) movement of the cord after 1 min.

34.2 To determine the acceptability of the means for strain relief on a flexible cord, the cord conductors are first to be cut at the point of their internal termination, then a force of 35 lb (154 N) is to be gradually applied and maintained for 1 min. The force is to be applied normal to the plane of the cord-exit hole.

MANUFACTURING AND PRODUCTION TESTS

35 Dielectric Voltage-Withstand Test

35.1 Each fence controller shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 Hz, between the primary wiring, including connected components, and:

a) Accessible dead-metal parts that are likely to become energized, and

b) Accessible low-voltage – 42.4 V peak or less – metal parts, including terminals.

Exception: This test is not required for low-voltage, battery-operated fence controllers.

35.2 The production line test shall be in accordance with either Condition A or Condition B of Table 35.1.

Table 35.1
Production-line test conditions

	Potential, V	Time, s
Condition A	1.25 V[a]	60
Condition B	1.5 V[a]	1

[a] V is the highest peak voltage that can exist between the primary supply circuit and the enclosure as determined in accordance with 35.1 but in no case is the test potential to be less than 1500 V for Condition A or 1800 V for Condition B.

35.3 The fence controller may be in a heated or unheated condition for the test.

35.4 The test shall be conducted when the fence controller is complete (fully assembled). It is not intended that the fence controller be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a surge arrester, snap-cover, or friction-fit knob, that would interfere with performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed fence controller.

35.5 A fence controller employing a solid-state component that is not relied upon to reduce the risk of electric shock, and that can be damaged by the dielectric potential may be tested before the component is electrically connected. The circuitry may be rearranged for the purpose of the test to reduce the likelihood of solid-state-component damage while retaining representative dielectric stress of the circuit.

35.6 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic feature that rejects any unacceptable unit.

35.7 If the output of the test equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

35.8 If the output of the test equipment transformer is 500 VA or more, the test potential may be indicated:

a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,

b) By a selector switch marked to indicate the test potential, or

c) For equipment having a single test potential output, by a marking in a readily visible location to indicate the test potential. When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

35.9 When the test equipment is adjusted to produce the specified test voltage and a resistance of 150,000 Ω is connected across the output, the test equipment is to indicate an unacceptable performance within 0.5 s. A resistance of more than 150,000 Ω may be used to produce an indication of unacceptable performance if the manufacturer elects to use a tester of higher sensitivity.

35.10 Test equipment other than that described in 35.6 – 35.8 may be used if found to accomplish the intended factory control.

35.11 During the test, all switches are to be in the on position, both sides of the primary circuit of the fence controller are to be connected together and to one terminal of the test equipment, and the second test equipment terminal is to be connected to the accessible dead-metal except the fence terminal.

36 Output Characteristics Tests

36.1 Each fence controller shall be tested, as a routine production-line test, to determine that the on-period, off-period, and peak-output current are within an acceptable range for the model being produced. The values obtained during production-line testing shall be in accordance with Section 22, Output Characteristics Test.

36.2 The peak-output current and on-period of each fence controller are to be determined by the use of a cathode-ray oscilloscope with the output of the controller connected to a 500 Ω resistive load. The on-period is considered to be the duration of the pulse from the initial rise above an absolute value of 5 mA until the last time the pulse falls below an absolute value of 5 mA for at least 0.1 s. The off-period is to be

determined by observing the length of time for 5 output pulses to the nearest one-tenth of a second, then dividing the total time by 5, and finally subtracting the on-period duration from this calibration time per pulse.

36A Direct Plug-In Tests

36A.1 General

36A.1.1 Direct plug-in controllers of 10.4 shall comply with 36A.2 – 36A.6. See 10.4.4(c)(1).

36A.2 Blade secureness test

36A.2.1 Each blade and the grounding pin, if provided, shall withstand a direct pull of 20 pounds-force (89 N) for 2 minutes without loosening. The two blades tested together shall also withstand a direct pull of 20 pounds for 2 minutes without loosening.

36A.2.2 To determine whether a controller complies with the requirement in 36A.2.1, it is to be supported on a horizontal steel plate with the blades projecting downward through a hole having a diameter sufficient only to permit the blades to pass through it. A 20-pound (9.1-kg) weight is to be supported by each blade and the grounding pin, if provided, in succession and then by the two blades tested together. In a controller of nonrigid construction - for example, a controller of soft molded material - the displacement of either blade shall not exceed 3/32 inch (2.4 mm) measured 2 minutes after removal of the weight.

36A.3 Security of input contacts test

36A.3.1 The plug-in blades and the grounding pin shall not loosen to a degree that introduces a risk of fire or electric shock as a result of the tests described in 36A.3.2 and 36A.3.3.

36A.3.2 A controller is to be rigidly supported in the blades-up position. Each blade, in turn, is to be individually subjected to a force of 30 pounds-force (133 N) applied gradually along the longitudinal axis of the blade in a direction towards the face of the controller. The 30 pounds-force is to be maintained for 1 minute.

36A.3.3 The sample used in 36A.3.2 is to be retested by being positioned as described in 36A.3.2 and subjecting both blades and the grounding pin, if provided, in combination, to a single applied force of 40 pounds-force (178 N) for 1 minute.

36A.4 Security of output connectors test

36A.4.1 For a controller provided with wire-binding terminals as output connectors, a terminal or terminal stud shall not turn or cause stress on internal connections when subjected to the test of 36A.4.2.

36A.4.2 The appropriate torque specified in Table 36A.1 is to be applied for 10 seconds to the terminals in a direction tending to tighten them. The terminals are then to be loosened fully.