



UL 773A

STANDARD FOR SAFETY

Nonindustrial Photoelectric Switches for
Lighting Control

UL Standard for Safety for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A

Sixth Edition, Dated January 19, 2016

Summary of Topics

This revision of ANSI/UL 773A dated January 16, 2024 is being issued to incorporate the following requirements:

- Requirements for Push-in Type Terminals; [2.5.4](#), [8.1.12A](#), [8.1.12B](#), [8.1.12C](#), [8.1.12D](#), Clause [34A](#), and [Table 42.1](#)***
- Requirements for field wiring terminals; [2.4](#), [8.1.7A](#), [8.1.7B](#), and Clause [34B](#)***
- Separable Terminal Assembly; [2.4](#), [2.5.4](#), [2.5.5](#), [8.1.14](#), Clause [8.2A](#), Clause [8.2B](#), Clause [40.4](#), Clause [40.5](#), Clause [40.6](#), Clause [40.7](#), Clause [40.8](#), Clause [40.9](#), Clause [40.10](#), Clause [40.11](#), [Table 42.1](#), and Annex [A](#)***

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 16, 2023 and November 13, 2023.

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Association of Standardization and Certification
NMX-J-715-ANCE
First Edition



CSA Group
CSA C22.2 No. 284-16
First Edition

I



ULSE Inc.
UL 773A
Sixth Edition

Nonindustrial Photoelectric Switches for Lighting Control

January 19, 2016

(Title Page Reprinted: January 16, 2024)

Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (operating as "CSA Group"), and ULSE Inc. (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or ULSE at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and ULSE. CSA Group and ULSE will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and ULSE pages.

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This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through January 16, 2024. The most recent designation of ANSI/UL 773A as an American National Standard (ANSI) occurred on January 16, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

The Department of Defense (DoD) has adopted UL 773A on June 13, 1989. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to 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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CONTENTS

PREFACE	7
---------------	---

INTRODUCTION

1 Scope	9
2 General	9
2.1 Components	9
2.2 Units of measurement	9
2.3 Undated references	9
2.4 Normative references	9
2.5 Definitions	12
2.6 Suitability for control of loads	12
2.7 Grounding/Bonding Conductor	12

CONSTRUCTION

3 Enclosures	13
3.1 General	13
3.2 Metal Enclosures	13
3.3 Polymeric enclosure	15
3.4 Snap-on covers	15
4 Accessibility of Uninsulated Live Parts	16
5 Openings in Enclosure	19
5.7 Knockouts	20
6 Provision for Mounting	20
7 Protection Against Corrosion	21
8 Supply Connections	22
8.1 Permanently connected units	22
8.2 Outlet-box-mounted units	24
8.2A Separable terminal assembly	25
8.2B Supply wiring leads	25
8.3 Cord-connected or direct plug-in units	25
8.4 Receptacles Incorporated in Equipment	26
8.5 Direct Plug-in	27
8.6 Strain relief	29
8.7 Bushings	29
9 Bonding/Grounding	29
9.7 Bonding/Grounding lead requirements	30
9.8 Bonding/Grounding lead securement	31
10 Current-Carrying Parts	31
11 Internal Wiring	31
12 Spacings	31
13 Alternate Spacings – Clearances and Creepage Distances	32
13.4 Limited power point determination	32
13.5 Printed-wiring board abnormal operation test	35
14 Bonding of Internal Parts for Bonding/Grounding	36
14.1 General	36
14.2 Construction and connection	38
15 Polymeric Materials	39
16 Coil Windings	41
17 Air-Gap Switches	41

PERFORMANCE

18	General	41
19	Overload and Endurance Testing – General.....	42
	19.1 General.....	42
	19.2 Air-gap switch used in series with solid state switching devices	43
20	Overload Test.....	43
21	Endurance Test.....	45
22	Temperature Test	52
23	Dielectric Voltage-Withstand Test	54
24	Operation Test	55
25	Abnormal Switching Test.....	55
26	Limited Short-Circuit Test for Solid-State Switching Control	56
27	Rain Test	57
28	Exposure to Humid Atmospheres	60
29	Permanence of Marking Tests	60
	29.1 Requirements for pressure sensitive labels.....	60
	29.2 Oven-aging test.....	60
	29.3 Immersion test.....	61
	29.4 Standard-atmosphere test	61
	29.5 Unusual-conditions exposure test	61
30	Bonding/Grounding Connection Tests	61
	30.1 Creep and mold stress relief	61
	30.2 Overcurrent tests	62
	30.3 Impedance test.....	62
31	Leakage Current Test	62
32	Leakage Current Following Humidity Conditioning Test	66
33	Power Supply Abnormal Tests	66
	33.1 General.....	66
	33.2 Output loading.....	67
	33.3 Power supply burnout	67
	33.4 Power supply abnormal test.....	68
34	Component Breakdown Test	68
	34.1 Effects on equipment	68
	34.2 Effects on controlled load	69
	34.3 Component evaluation	69
34A	Push-in Terminal Tests	69
34B	Push-in Temperature Test.....	69
35	Strain Relief and Lead Securement Tests	70
	35.1 Strain relief – cord-connected device.....	70
	35.2 Lead securement – for self enclosed devices with nipples.....	70
	35.3 Lead securement – outlet box mounted devices	70
36	Knockout Test	70
37	Mechanical integrity.....	71
	37.1 Impact test for outdoor devices	71
	37.2 Crush test	71
38	Conduit Connection to Enclosure Tests	71
	38.1 Polymeric Enclosures	71
	38.2 Metallic enclosure threaded opening test.....	72
	38.3 Metallic enclosure conduit hub test.....	72
39	Snap-On Cover Test	72
40	Tests on 120V Devices with Varistors	73
	40.3 Test requirements	73
	40.4 Separable terminal assembly – retention of tab connection test.....	74
	40.5 Separable terminal assembly – pull test.....	74
	40.6 Separable terminal assembly – mold stress relief test.....	74



40.7 Separable terminal assembly – humidity conditioning followed by dielectric test 74

40.8 Separable terminal assembly – short circuit withstand test 75

40.9 Separable terminal assembly – latching mechanism test..... 75

40.10 Separable terminal assembly – abnormal overload test..... 76

40.11 Separable terminal assembly - continuity impedance test..... 76

MANUFACTURING AND PRODUCTION TESTS

41 Dielectric Voltage-Withstand Test 77

RATINGS, MARKINGS AND INSTRUCTIONS

42 Details 78

43 Instructions 85

44 Marking requirements for minimum outlet box volume 85

ANNEX A (Informative)French translations and markings

No Text on This Page

PREFACE

This is the harmonized ANCE, CSA Group, and ULSE standard for Nonindustrial Photoelectric Switches for Lighting Control. It is the first edition of NMX-J-715-ANCE, the first edition of CSA-C22.2 No. 284-16, and the sixth edition of UL 773A. This edition of UL 773A supersedes the previous edition published on February 10, 2006. This harmonized standard has been jointly revised on January 16, 2024. For this purpose, CSA Group and ULSE are issuing revision pages dated January 16, 2024, and ANCE is issuing a new edition dated January 16, 2024.

This harmonized standard was prepared by the Association of Standardization and Certification, (ANCE), CSA Group and ULSE Inc. (ULSE). The efforts and support of the Technical Harmonization Subcommittee, on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

The CSA Group standard also replaces the following Technical Information Letters (T.I.L.), for products covered in this Standard:

– TIL No. A-15 Photo-electric switches

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

The present Mexican standard was developed by the CT 23 Electrical Accesries from the Comité de Normalización de la Asociación de Normalización y Certificación, A.C., CONANCE, with the collaboration of the Electrical of manufactures, manufacturers and users.

This standard was reviewed by the CSA Integrated Committee on Wiring Devices, under the jurisdiction of the CSA Technical Committee on Wiring Products and the CSA Strategic Steering Committee on requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with the Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

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

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

Level of Harmonization

This standard is published as an identical standard for ANCE, CSA Group and ULSE.

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

Reasons for Differences From IEC

There is no corresponding IEC standard.

Interpretations

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

INTRODUCTION

1 Scope

1.1 Requirements contained in this Standard cover controls of the light-sensitive or presence-sensitive types, or both; for indoor or outdoor service; intended for the control of indoor or outdoor loads up to a maximum of 20 A and maximum 347 V; intended for installations on 50 Hz or 60 HZ systems or DC up to 60 V (for US); and DC up to 42.4 V (for Canada); and intended to be installed in accordance with the National Electrical Code (NEC), NFPA 70, the Canadian Electrical Code (CE Code) Part I, CSA C22.2 No. 0, and NOM 001 SEDE.

1.2 These requirements do not cover controls intended to be used under the following conditions:

- a) Devices that are locking type, used for area or roadway lighting fixtures;
- b) Devices that monitor or control safety critical loads or personal protection circuits;
- c) Devices intended to be installed in areas designated hazardous locations;
- d) Devices intended to be installed for manufacturing process control.

2 General

2.1 Components

2.1.1 A component of a product covered by this standard shall comply with the requirements for that component. A component shall be used in accordance with its rating established for the intended conditions of use.

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

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

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

2.2 Units of measurement

2.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information. SI (metric) units shall be normative, except for trade sizes.

2.3 Undated references

2.3.1 For undated references to Standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved.

2.4 Normative references

2.4.1 Products covered by this Standard shall comply with the referenced installation codes and standards noted in this Clause.

CSA Group Standards

Note: For products intended for use in Canada, general requirements are given in CSA-C22.2 No. 0

C22.1-15

Canadian Electrical Code (CE Code), Part I

CSA C22.2 No. 0

General requirements – Canadian Electrical Code, Part II

CSA 22.2 No. 0.2

Insulation Coordination

CSA 22.2 No. 0.17

Evaluation of Properties of Polymeric Materials

CSA 22.2 No. 42

General Use Receptacles, Attachment Plugs, and Similar Wiring Devices

CSA 22.2 No. 42.1

Cover plates for flush-mounted wiring devices

CSA C22.2-111

General-Use Snap Switches

CSA C22.2 No. 184.1

Solid-state dimming controls

CSA C22.2 No. 284-16

Nonindustrial photoelectric switches for lighting control

CSA 18.1

Metallic Outlet Boxes

CSA 66.1

Low Voltage Transformers – Part 1: General Requirements

CSA 66.3

Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

CSA 223

Power Supplies With Extra-Low-Voltage Class 2 Outputs

UL Standards

UL 498

Attachment Plugs and Receptacles

UL 60730-1

Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements

UL 1414

Capacitors and Suppressors for Radio- and Television-Type Appliances

UL 1310
Class 2 Power Units

UL 61810-1
Electromechanical Elementary Relays – Part 1: General Requirements

UL 157
Gaskets and Seals

UL 20
General-Use Snap Switches

UL 508
Industrial Control Equipment

UL 514D
Cover Plates for Flush-Mounted Wiring Devices

UL 840
Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment

UL 5085-3
Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers

UL 5085-1
Low Voltage Transformers – Part 1: General Requirements

UL 514A
Metallic Outlet Boxes

UL 773
Plug-In Locking Type Photocontrols for Use with Area Lighting

UL 746E
Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards

UL 746A
Polymeric Materials – Short Term Property Evaluations

UL 746C
Polymeric Materials – Use in Electrical Equipment Evaluations

UL 796
Printed-Wiring Boards

UL 244A
Solid-State Controls for Appliances

UL 1472
Solid-State Dimming Controls

UL 1449

Surge Protective Devices

ANCE Standards

ANCE NMX-J-005

ANCE NMX-J-023/1

ANCE NMX-J-412

2.5 Definitions

2.5.1 **Enclosure** – The part of the device that:

- a) Renders inaccessible all or any parts of the device that may present a risk of electric shock; and
- b) Retards propagation of fire initiated from within the device

2.5.2 **Outlet-box device** – A device intended to be installed in an electrical box, with or without a cover plate.

2.5.3 **Snap-on cover** – A cover that is held in place by friction-fit and not requiring the use of a tool for removal.

2.5.4 **Terminal, Push-In** – A terminal where the stripped end of a conductor is pushed into the terminal and the clamping pressure is maintained by a spring mechanism, without the use of screws.

2.5.4A **Photoelectric Switch, Modular Assembly** – A device consisting of a separable terminal assembly and photoelectric switch.

2.5.5 **Separable Terminal Assembly** – A two-piece terminal provided with an integral mechanical latching mechanism(s). May be either installed (i.e., special purpose connector) into a device box or secured (i.e., back plate) to the device box. Provided with either insulated conductors or wiring terminals for connection to the branch circuit conductors.

2.6 Suitability for control of loads

2.6.1 A device suitable for control of receptacles shall have a rating equivalent to the rating (amps, hp) of the receptacle(s) it is intended to control.

2.6.2 A device intended for pilot duty loads shall be tested for the specific load and so marked.

2.7 Grounding/Bonding Conductor

– a conductor that is defined in the National Electrical Code (NEC) as an Equipment Grounding Conductor, and a conductor that is defined in the Canadian Electrical Code (CE Code), Part I, as a Bonding Conductor.

CONSTRUCTION

3 Enclosures

3.1 General

3.1.1 The enclosure of a unit shall be strong and rigid so as to resist the abuses likely to be encountered in the operation of the unit. The degree of resistance inherent in the unit shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other serious defects which alone or in combination may increase the risk of fire, electric shock, or injury to persons.

3.1.2 Devices rated for outdoor use or wet locations shall comply with the Rain Test, Clause [27](#).

3.2 Metal Enclosures

3.2.1 A cast-metal enclosure shall be at least 3.2 mm (1/8 in) thick at every point, more than 3.2 mm (1/8 in) thick at reinforcing ribs and door edges, and not less than 6.4 mm (1/4 in) thick at tapped holes for conduit.

3.2.2 Other than at plain or threaded conduit holes, die-cast metal may be:

a) Not less than 2.4 mm (3/32 in) thick for an area greater than 155 cm² (24 in²) or having any dimensions more than 152 mm (6 in); and

b) Not less than 1.6 mm (1/16 in) thick for an area of 155 cm² (24 in²) or less and having no dimensions more than 152 mm (6 in). The area limitation may be obtained by the provision of reinforcing ribs subdividing a larger area.

3.2.3 The cast-metal enclosure described in [3.2.1](#) or an enclosure of sheet metal having the construction indicated in [Table 3.1](#) or [Table 3.2](#) will generally be considered to have an acceptable level of the factors indicated in Clause [3](#), Enclosures.

Table 3.1
Minimum thickness of sheet metal for enclosures –
carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness			
Maximum width ^b		Maximum length of supported edge ^c		Maximum width ^b	Maximum length	Thickness Uncoated	Minimum thickness metal coated
cm	(inches)	cm	(inches)	cm	(inches)	cm	(inches)
10.2	(4.0)	Not limited		15.9	(6.25)	Not limited	
12.1	(4.75)	14.6	(5.75)	17.1	(6.75)	21.0	(8.25)
15.2	(6.0)	Not limited		24.1	(9.5)	Not limited	
17.8	(7.0)	22.2	(8.75)	25.4	(10.0)	31.8	(12.5)
20.3	(8.0)	Not limited		30.5	(12.0)	Not limited	
22.9	(9.0)	29.2	(11.5)	33.3	(13.0)	40.6	(16.0)
31.8	(12.5)	Not limited		49.5	(19.5)	Not limited	
35.6	(14.0)	45.7	(18.0)	53.3	(21.0)	63.5	(25.0)
						1.07	(0.042)
						1.14	(0.045)

Table 3.1 Continued on Next Page

Table 3.1 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness	
Maximum width ^b	Maximum length of supported edge ^c	Maximum width ^b	Maximum length	Thickness Uncoated	Minimum thickness metal coated
cm (inches)	cm (inches)	cm (inches)	cm (inches)	cm (inches)	cm (inches)
45.7 (18.0)	Not limited	68.6 (27.0)	Not limited		
50.8 (20.0)	63.5 (25.0)	73.7 (29.0)	91.4 (36.0)	1.35 (0.053)	1.42 (0.056)
55.9 (22.0)	Not Limited	83.8 (33.0)	Not Limited		
63.5 (25.0)	78.7 (31.0)	88.9 (35.0)	109.2 (43.0)	1.52 (0.060)	1.60 (0.063)
63.5 (25.0)	Not Limited	99.1 (39.0)	Not Limited		
73.7 (29.0)	91.4 (36.0)	104.1 (41.0)	129.5 (51.0)	1.70 (0.067)	1.78 (0.070)
83.8 (33.0)	Not Limited	129.5 (51.0)	Not Limited		
96.5 (38.0)	119.4 (47.0)	137.2 (54.0)	167.6 (66.0)	2.03 (0.080)	2.13 (0.084)
106.7 (42.0)	Not Limited	162.6 (64.0)	Not Limited		
119.4 (47.0)	149.9 (59.0)	172.7 (68.0)	213.4 (84.0)	2.36 (0.093)	2.46 (0.097)
132.1 (52.0)	Not Limited	203.2 (80.0)	Not Limited		
152.4 (60.0)	188.0 (74.0)	213.4 (84.0)	261.6 (103.0)	2.74 (0.108)	2.82 (0.111)
160.0 (63.0)	Not Limited	246.4 (97.0)	Not Limited		
185.4 (73.0)	228.6 (90.0)	261.6 (103.0)	322.6 (127.0)	0.123 (0.123)	3.20 (0.126)

^a See 3.2.5 for description of supporting frame and method for accomplishing equivalent reinforcing.

^b The width is the smaller dimension of a rectangular piece of sheet metal that is part of an enclosure. Adjacent surfaces of an enclosure may have common supports and be made of a single sheet.

^c Not limited applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

^d Sheet steel for an enclosure intended for outdoor use - raintight or rainproof - shall not be less than 0.86 mm (0.034 inch) thick if zinc coated and not less 0.81 mm (0.032 inch) thick if uncoated.

Table 3.2
Minimum thickness of sheet metal for enclosures aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness
Maximum width ^b	Maximum length ^c	Maximum width ^b	Maximum length	
cm (inches)	cm (inches)	cm (inches)	cm (inches)	mm (inch)
7.6 (3.0)	Not limited	17.8 (7.0)	Not limited	
8.9 (3.5)	10.2 (4.0)	21.6 (8.5)	24.1 (9.5)	0.58 (0.023 ^d)
10.2 (4.0)	Not limited	25.4 (10.0)	Not limited	
12.7 (5.0)	15.2 (6.0)	26.7 (10.5)	34.3 (13.5)	0.74 (0.029)
15.2 (6.0)	Not limited	35.6 (14.0)	Not limited	
16.5 (6.5)	20.3 (8.0)	38.1 (15.0)	45.7 (18.0)	0.91 (0.036)
20.3 (8.0)	Not limited	48.3 (19.0)	Not limited	
24.1 (9.5)	29.2 (11.5)	53.3 (21.0)	63.5 (25.0)	1.14 (0.045)
30.5 (12.0)	Not limited	71.1 (28.0)	Not limited	

Table 3.2 Continued on Next Page

Table 3.2 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness
Maximum width ^b	Maximum length ^c	Maximum width ^b	Maximum length	
cm (inches)	cm (inches)	cm (inches)	cm (inches)	mm (inch)
35.6 (14.0)	40.6 (16.0)	76.2 (30.0)	94.0 (37.0)	1.47 (0.058)
45.7 (18.0)	Not limited	106.7 (42.0)	Not limited	
50.8 (20.0)	63.5 (25.0)	114.3 (45.0)	139.7 (55.0)	1.91 (0.075)
63.5 (25.0)	Not limited	152.4 (60.0)	Not limited	
73.7 (29.0)	91.4 (36.0)	162.6 (64.0)	198.1 (78.0)	2.41 (0.095)
94.0 (37.0)	Not limited	221.0 (87.0)	Not limited	
106.7 (42.0)	134.6 (53.0)	236.2 (93.0)	289.6 (114.0)	3.10 (0.122)
132.1 (52.0)	Not limited	312.4 (123.0)	Not limited	
152.4 (60.0)	188.0 (74.0)	330.2 (130.0)	406.4 (160.0)	3.89 (0.153)

^a See 3.2.5 for description of supporting frame and method for accomplishing equivalent reinforcing.

^b The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c Not limited applies only if the edge of the surface is flanged at least 12.7 mm (1/2 inch) or fastened to adjacent surfaces not normally removed in use.

^d Sheet copper, brass, or aluminum for an enclosure intended for outdoor use – raintight or rainproof – shall not be less than 0.74 mm (0.029 inch) thick.

3.2.4 [Table 3.1](#) and [Table 3.2](#) are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

3.2.5 With reference to [Table 3.1](#) and [Table 3.2](#), a supporting frame is a structure of angle or channel or folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied by the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- a) Single sheet with single formed flanges – formed edges;
- b) A single sheet that is corrugated or ribbed;
- c) An enclosure surface loosely attached to a frame, for example, with spring clips; and
- d) An enclosure surface having an unsupported edge.

3.3 Polymeric enclosure

3.3.1 A polymeric (non-metallic) enclosure shall comply with the requirements of Clause [15](#), Polymeric Materials.

3.4 Snap-on covers

3.4.1 Snap-on covers shall not permit access to live parts as described in [4.7](#). When snap on covers are required for compliance with other sections of this standard, they shall be evaluated to the Snap-On Cover Test, Clause [39](#).

3.4.2 The enclosure shall have provision for the connection of a wiring system suitable for the application.

4 Accessibility of Uninsulated Live Parts

4.1 Construction shall be such that uninsulated live parts that may involve a risk of electric shock shall not be accessible to contact by user under conditions of normal use including use as described in [4.7](#).

4.2 A live part is considered to involve a risk of electric shock unless it is in one of the following circuits:

a) A circuit supplied by one or more isolated secondary windings of a transformer or equivalent power supply in which the maximum possible open circuit voltage at the transformer is less than:

- 1) 30 V (42.4 V peak) where wet contact is not likely to occur; and
- 2) 15 V (21.2 V peak) where wet contact is likely to occur

b) A circuit derived from a source other than that described in (a) in which the available current is limited to 0.5 mA, regardless of supply polarity. The current shall be measured between accessible points and from these points to earth ground through a 1500-Ω resistor. If circuit impedance is used to limit the current, the circuitry shall comply with the requirements specified in [4.3](#) and [4.4](#).

c) A dry-cell battery having output characteristics not greater than those of an energy-limiting Class 2 transformer or power source;

d) A combination of a rechargeable battery and a fixed impedance that complies with all of the performance requirements for an energy-limiting Class 2 transformer or power source; or

e) Terminals or conductors intended to extend in the building wiring that are part of a Class 2 circuit and comply with Class 2 power supply requirements.

4.3 Class 2 transformers shall comply with performance and marking requirements in the Standard for Low Voltage Transformers: General Requirements, UL 5085-1/CSA 66.1; and the Standard for Low Voltage Transformers: Class 2 Transformers, UL 5085-3/CSA 66.3. Class 2 power units shall comply with performance and marking requirements in the Standard for Class 2 Power Units, UL 1310 and CSA 223.

4.4 Power supply circuits having accessible live parts shall comply with [4.3](#). Power supply circuits having accessible live parts complying with the tests of Clause [33](#), Power Supply Abnormal Tests, shall be considered to comply with the performance requirements of [4.3](#).

4.5 The circuit impedance described in [4.2](#) (b) shall be provided by two independent means. Either independent means shall limit the available leakage current to less than 0.5 mA.

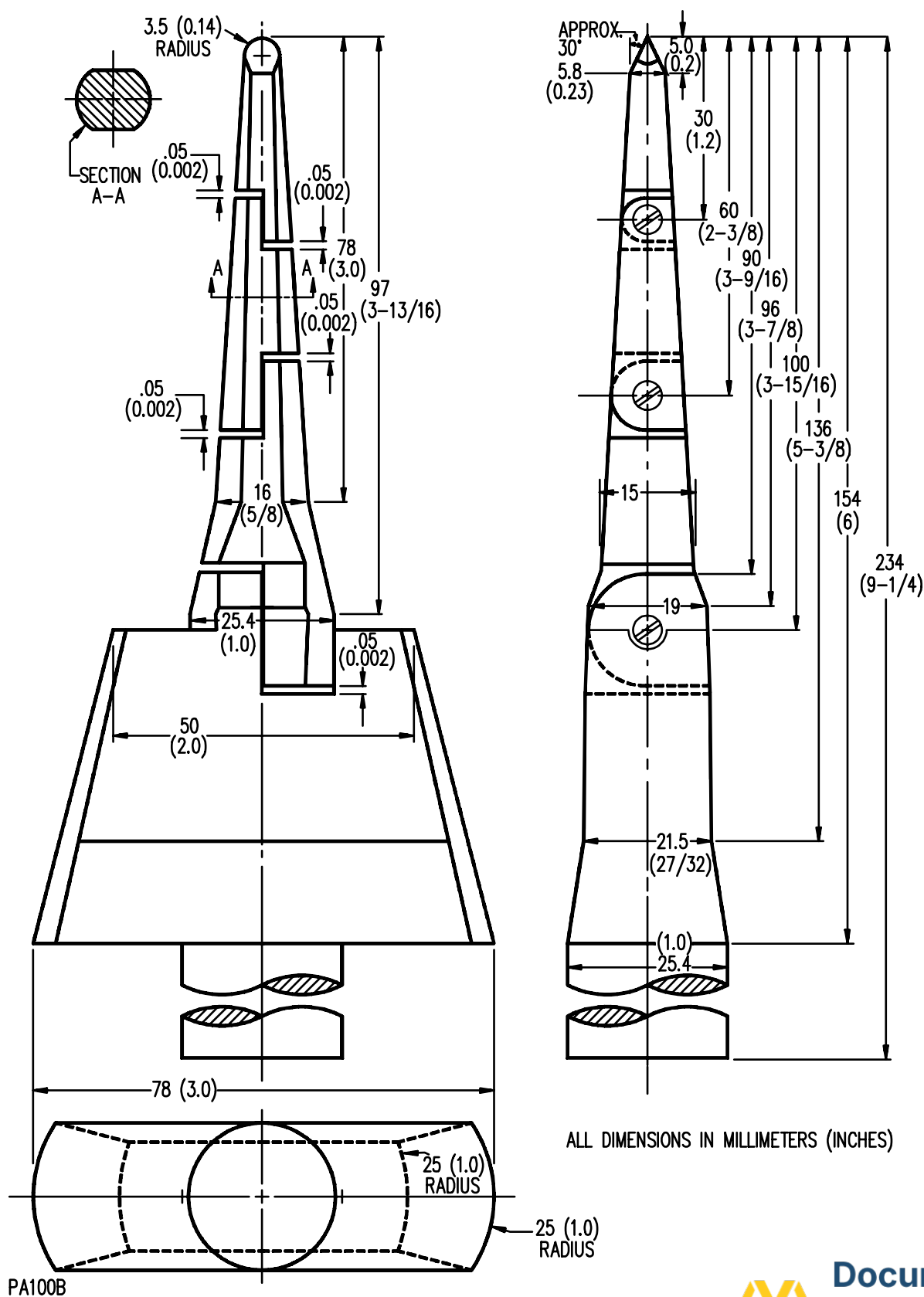
4.6 With respect to [4.3](#), the following components can be used for the application:

- a) Metal film, carbon film, wire wound, and metal glazed resistors;
- b) Metallized polyester film capacitors;
- c) Antenna-coupling capacitors, and line-by-pass capacitors that comply with the Standard for Capacitors and Suppressors for Radio- and Television-Type Appliances, UL 1414; and
- d) Other components, if investigated and found acceptable for the application.

4.7 For supplies of circuits of the types specified in [4.2](#) (b), the minimum spacings shall be in accordance with Spacings, Clause [12](#), or Alternate Spacings – Clearances and Creepage Distances, Clause [13](#).

4.8 The probe illustrated in [Figure 4.1](#), when inserted through an opening in an enclosure, guard, or operator accessible barrier, shall not touch any uninsulated live part that involves a risk of electric shock. See [4.9](#). The probe shall be rotated with the movable sections straight or in any possible position resulting from bending one or more sections in the same direction. The maximum force applied to the probe shall not exceed approximately 10 N.

Figure 4.1
Articulate probe with web stop



4.9 If any part of the enclosure must be opened or removed as part of energized set-up, normal operation, regular adjustment, or regular or required maintenance (set point adjustment, timer or time of day clock adjustment, battery replacement, or similar maintenance) with or without the use of tools, or can be opened or removed without the use of tools, the accessibility probe shall be applied without the part in place. The maximum force applied to the probe shall be 20 N (4.5 lb).

4.10 If a marking or an operating instruction refers a user to a hole or opening in an enclosure through which a tool is to be inserted for adjustment or a similar purpose, it shall not be possible to contact an un-insulated live part through the hole or opening with a 1.6-mm (1/16-inch) diameter rod. Maximum force shall not be greater than 10 N.

5 Openings in Enclosure

5.1 Openings in an enclosure shall not have any dimensions large enough to permit the entrance of a 25.4 mm (1 in) diameter rod, and shall comply with [5.2](#) – [5.6](#). The maximum force applied to the probe shall be 20 N (4.5 lb).

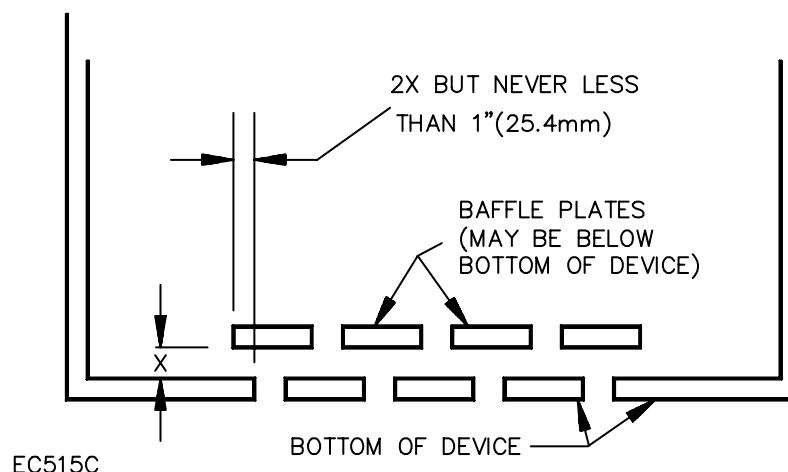
5.2 An opening shall not be provided in a compartment or part of an enclosure intended for field-wiring connections in a line-voltage circuit.

5.3 Openings in the mounting surface shall be limited to the following:

- a) A mounting opening that complies with Provision for Mounting, Clause [6](#).
- b) A maximum of four openings provided for the escape of air or paint during a painting process. The maximum dimension of such an opening shall not exceed 3.2 mm (1/8 in).
- c) A maximum of four unused holes provided for mounting of internal components. The maximum dimension of such an opening shall not exceed 4.8 mm (3/16 in).

5.4 An opening may be provided in the bottom surface of an enclosure if the opening does not permit materials to fall directly out from the interior of the unit. [Figure 5.1](#) illustrates a construction that meets this requirement.

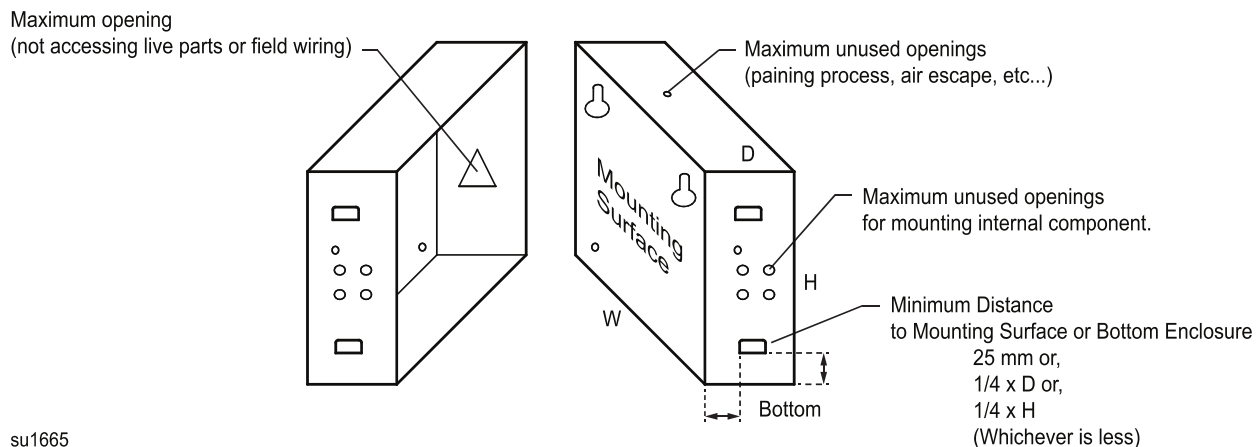
Figure 5.1
Bottom surface opening of an enclosure



5.5 The shortest distance between an opening and the bottom of an enclosure or a wall-mounting surface shall be at least one-quarter of the enclosure height or depth, respectively, or 25.4 mm (1 in), whichever is less – see [Figure 5.2](#).

Figure 5.2

Examples of Shortest Distances from Enclosure Openings



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5.6 There shall be no emission of flame or molten material through an opening, or manifestation of risk of fire, during normal tests or during abnormal tests, such as transformer burnout.

5.7 Knockouts

If a knockout is provided, it shall comply with [Table 5.1](#) and [Clause 36](#), Knockout Test.

Table 5.1
Knockout diameters and width of flat surface surrounding knockouts

Trade size of conduit (metric designator)		Minimum width of flat surface surrounding knockout, mm (in)		Knockout diameters, mm (in)					
				Minimum		Nominal		Maximum	
1/2	(16)	3.38	(0.133)	21.84 ^a	(0.860)	22.23	(0.875)	22.61	(0.890)
3/4	(21)	3.68	(0.145)	27.79 ^b	(1.094)	28.17	(1.109)	28.96	(1.140)
1	(27)	4.72	(0.186)	34.52	(1.359)	34.93	(1.375)	35.71	(1.406)
1-1/4	(35)	6.45	(0.254)	43.66	(1.719)	44.04	(1.734)	44.83	(1.765)
1-1/2	(41)	7.80	(0.307)	49.73	(1.958)	50.39	(1.984)	51.20	(2.016)
2	(53)	8.97	(0.353)	61.80	(2.433)	62.71	(2.469)	63.50	(2.500)
^a In Canada, a reduced diameter of 21.46 mm (0.8 in) on a multiple knockout shall be allowed.									
^b In Canada, a reduced diameter of 27.05 mm (1.065 in) on a multiple knockout shall be allowed.									

6 Provision for Mounting

6.1 Provision shall be made for securely mounting a permanently connected unit in position. Bolts, screws, or other parts used for assembling the unit shall be independent of those used for securing component parts of the unit to the frame, base, or panel.

6.2 Bolts, screws, or other parts used for assembling the unit shall be independent of those used for securing component parts of the unit to the frame, base, or panel.

6.3 There shall be no more than four holes for mounting.

6.4 A cord-connected unit shall not include means for permanent mounting. One or two keyhole slots for wall hanging may be provided if the hanging screws, nails, and similar means, are not accessible for tightening, and if long nails, hooks, or screws for hanging will not be likely to touch internal wiring, the operating mechanism, or live parts and will not result in spacings less than those required in [12.1](#). Blind key hole slots are considered suitable to fulfill this requirement.

7 Protection Against Corrosion

7.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if the corrosion of such unprotected parts might result in a risk of fire, electric shock, or injury to persons.

7.2 Thermal elements, magnet pole faces, and hardened and polished parts such as latching surfaces, and similar parts where such protection is impractical need not be protected.

7.3 The metal enclosure of an indoor switch need not be protected.

7.4 Phosphate treatment with an oil or wax coating is acceptable as corrosion protection for magnets and armatures; oil treatment is acceptable as corrosion protection for steel springs; and stainless steel is acceptable without additional protection, if polished or treated.

7.5 All surfaces of a raintight metal enclosure, and all attached metal parts of such an enclosure, shall be protected against corrosion by one of the coatings described in [7.6](#) and [7.7](#), unless the metal is inherently resistant to corrosion. Metals used in combinations shall be galvanically compatible.

7.6 A sheet steel enclosure shall be protected against corrosion as specified in (a) – (d).

a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G90 in the Weight (Mass) of Coating Requirements table in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM specification. The weight of the zinc coating may be determined by any method; however, in case of question the weight of coating shall be established in accordance with the Standard Test Method for Weight [Mass] of Iron or Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.015 mm (0.00061 in) on each surface with a minimum thickness of 0.014 mm (0.00054 in). An annealed coating shall comply with [7.7](#).

c) A zinc coating conforming with (1) or (2) and with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces after forming. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary.

1) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in the Weight (Mass) of Coating Requirements table in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM specification. Its weight

of zinc coating may be determined by the method; however, in case of question the weight of coating shall be established in accordance with the Standard Test Method for Weight [Mass] of Coating on Iron or Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90.

2) A zinc coating, other than that provided on hot-dipped mill galvanized sheet steel, uniformly applied to an average thickness of not less than 0.010 mm (0.00041 in) on each surface with a minimum thickness of 0.009 mm (0.00034 in).

d) Other finishes, including paints, metallic finishes, or combinations of the two may be accepted when comparative tests with galvanized sheet steel – without annealing, wiping or other surface treatment – conforming with (a), indicate they provide equivalent protection. Among the factors that are taken into consideration when judging the acceptability of such coating systems are exposure to salt spray, moist carbon-dioxide/sulphur-dioxide/air mixtures, moist hydrogen-sulphide/air mixtures, ultraviolet light, and water.

7.7 An annealed zinc coating that is bent or similarly formed after annealing and that is not otherwise required to be painted shall be painted in the bent or formed area if the bending or forming process damages the zinc coating, except that such areas on the inside surface of an enclosure that are not exposed to water during the rain test need not be painted. The zinc coating is considered to be damaged if flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification. Simple sheared or cut edges and punched holes are not considered to be formed.

8 Supply Connections

8.1 Permanently connected units

8.1.1 Leads, except for bare bonding/grounding leads, shall have insulation of a type rated for the purpose and have following minimum characteristics:

- a) Minimum free length of a lead shall be 100 mm (4 in).
- b) Field connections shall be copper.
- c) Ampacity of the lead be in accordance with [Table 8.1](#).
- d) Leads for Class 2 shall not be less than 22 AWG.
- e) Insulation except for bare ground lead.
- f) Insulation

Where leads are to be run through a strain relief, hub, nipple, tubing or conduit, insulation shall be suitable for raceway installation.

- g) Lead color

Green coloring, with or without one or more yellow stripes shall be used only for bonding/grounding conductors. White or gray shall be used only for grounded (identified) conductors). Colors other than indicated above may be used for conductors other than grounding and grounded.

- h) Solder shall not be relied upon to be the only means of securement for leads.

Table 8.1
Minimum size of leads

Lead rating (A)	Leads	
	AWG	(mm ²)
0 – 6	18	(0.82)
6.1 – 10	16	(1.3)
10.1 – 15	14	(2.1)
15.1 – 20	12	(3.3)

8.1.2 Lead sizes smaller than the ones shown in [Table 8.1](#) are permitted if in compliance with the Temperature Test in Clause [22](#) and marking requirements in [Table 42.1](#), item 26, but shall not be smaller than 18 AWG.

8.1.3 For a unit provided with field-wiring terminals, a field-wiring terminal shall be rated for the application. The terminal shall be rated for connection of a conductor as follows:

- a) A terminal intended to conduct 12 A or less shall be rated for connection of a 14 AWG (2.1 mm²) minimum supply conductor; and
- b) A terminal intended to conduct more than 12 A and up to 20 A shall be rated for connection of a 12 AWG (3.3 mm²) minimum supply conductor.

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

8.1.5 Terminal parts by which connections are made shall maintain connections even under hard usage. For 8 AWG (8.4 mm²) and larger wires, pressure wire connectors shall be used. For 10 AWG (5.3 mm²) and smaller wires, the parts to which the wiring connections are made may consist of clamps or binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position.

8.1.6 A wiring terminal shall be prevented from turning.

8.1.7 A wire-binding screw to which field-wiring connections are made shall not be smaller than No. 8 (4.2 diameter) except that a No. 6 (3.5 mm diameter) screw may be used for a terminal to which only 14 AWG (2.1 mm²) wire would be connected.

8.1.7A A wire-binding terminal screw shall comply with the requirements for the torque and pull-out tests, Clause [34B](#).

8.1.7B A wire-binding terminal screw of size 8-32 or 10-32 is not required to be tested.

8.1.8 A terminal plate tapped for a wire-binding screw shall be of metal not less than 1.27 mm (0.050 in) thick and shall have not less than two full threads in the metal. A plate less than 1.27 mm (0.050 in) but not less than 0.76 mm (0.030 in) thick may be acceptable if the tapped threads have appropriate mechanical strength.

8.1.9 A terminal plate formed from stock having the minimum required thickness, as specified in [8.1.8](#), may have the metal extruded at the tapped hole for the binding screw so as to provide two full threads.

8.1.10 A wire-binding screw shall thread into metal.

8.1.11 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is used, there shall be no less than three threads in the metal, and the construction of the unit shall be such that a conduit bushing can be attached as intended.

8.1.12 Unplated iron or steel shall not be used for wire-binding screws and terminals. Stainless steel, or steel that is protected against corrosion by zinc plating or the equivalent coating may be used, if the steel parts are not depended upon to carry current.

8.1.12A A push-in (screwless) terminal shall comply with the performance requirements in Push-In Terminal Test, Clause [34A](#), and shall be:

- a) For use with a solid copper conductor;
- b) For a current-carrying connection only, not for grounding; and
- c) Marked as indicated in item 28 of [Table 42.1](#).

8.1.12B Push-in terminals intended for use on branch circuit wiring shall be designed so that they will permit the use of a solid 14 AWG (2.1 mm²) conductor but will reject a 12 AWG (3.3 mm²) or larger solid conductor. The opening provided for the conductor shall reject a No. 48 drill rod, 1.981 ±0.0076 mm (0.076 ±0.0003 inch) in diameter. The rod shall be applied with 22 N (5 lbf). Openings, other than those intended for wire termination, such as wire release openings, shall not permit electrical contact to be made with a 14 AWG (2.1 mm²) conductor.

8.1.12C A switch employing "push-in" terminations may be provided with a means to release the conductors. Where an opening in the insulating body is provided for such purpose behind the plane of the mounting means, it shall not permit entry of a 14 AWG (2.1 mm²) solid conductor. The wire release means, if provided, shall be subject to the Push-In Terminal Tests, Clause [34A](#).

8.1.12D A release mechanism shall be located or guarded so that it cannot be unintentionally actuated during installation. The release mechanism may be guarded by recessing, ribs, barriers, or the like.

8.1.13 A Non Industrial Photoelectric switch employing field wiring terminals shall be provided with the manufacturers recommended terminal tightening torque. These instructions shall appear on the device where visible during installation, on the smallest unit container, or on an information sheet packed in the smallest unit container in accordance with [Table 42.1](#) Ref. 4a.

8.1.14 A photoelectric switch with a separable terminal assembly employing wiring terminals shall be uniquely keyed to prevent interchangeability of photoelectric switch where the wiring terminal conductor size ampacity is less than the photoelectric switch ampere rating.

8.2 Outlet-box-mounted units

8.2.1 In addition to the requirements in [8.1.1](#) – [8.1.12](#), an outlet-box-mounted unit shall comply with [8.2.2](#) – [8.2.5](#).

8.2.2 Wiring terminals and other live parts and sharp-edged grounded or dead metal parts of a unit intended for mounting on an outlet box or similar enclosure shall be located or protected so that they will not be forced against wiring in the box during installation.

8.2.3 With reference to [8.2.2](#), back wiring terminals may be employed if they are recessed or are protected by close-fitting barriers of insulating material or the equivalent so that contact with wiring installed in the box will not occur.