CSA GROUP™

CSA C22.2 No. 35:09
(reaffirmed 2019)

Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable

Standards Council of Canada
Conseil canadien des normes

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Revision History

CSA C22.2 No. 35:09, Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable

National Standard of Canada — August 2019
Outside front cover, National Standard of Canada text, and title page. This Standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Update No. 2
C22.2 No. 35-09
June 2014

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Title: *Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable* — originally published September 2009

Revisions issued: Update No. 1 — May 2010

The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

Revised	Clauses 7.2.2.2.1, 7.2.2.3, and 7.2.5.1 and Table 10
New	None
Deleted	None

- Update your copy by inserting these revised pages.
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6.4.2.2.2
Compliance with the cold bend test in Clause 6.4.2.2.1 shall be determined in accordance with the apparatus and method of the cold bend test of CAN/CSA-C22.2 No. 2556.

6.4.2.3 Heat shock

6.4.2.3.1
The insulation on a specimen of individual conductor shall show no cracks, either externally or internally, when wound six close turns around a mandrel having a diameter equal to the outside diameter of the specimen and then subjected to a temperature of 121 ± 1 °C for 1 h. After the specimen has been allowed to cool to 23 ± 2 °C, and while still on the mandrel, it shall withstand, without breakdown, for a period of 1 min, the dielectric strength test specified in Clause 6.4.2.4.

6.4.2.3.2
Compliance with the heat shock test in Clause 6.4.2.3.1 shall be determined in accordance with the apparatus and method of the heat shock test of CAN/CSA-C22.2 No. 2556.

6.4.2.4 Dielectric strength following the cold bend and heat shock tests

6.4.2.4.1
The dielectric strength test required in Clauses 6.4.2.2.1 and 6.4.2.3.1 shall consist of the application of an ac (rms) voltage of 2000 V for a period of 1 min applied between the conductor and the water after the specimen, except for the ends, has been immersed in tap water for 1 h at room temperature.

6.4.2.4.2
Compliance with the dielectric strength tests in Clauses 6.4.2.3.1 and 6.4.2.4.1 shall be determined in accordance with the apparatus and method of the dielectric voltage-withstand test of CAN/CSA-C22.2 No. 2556.

6.4.2.5 Flame — FT1

6.4.2.5.1
Finished Type ELC cables shall neither convey flame nor continue to burn more than 1 min after five 15 s applications of a standard test flame. A specimen shall be considered to have conveyed flame if more than 25% of the extended portion of the indicator is burned.

6.4.2.5.2
Compliance with the flame test in Clause 6.4.2.5.1 shall be determined in accordance with the apparatus and method of the flame test (FT1) of CAN/CSA-C22.2 No. 2556.

7 Golf course and lawn sprinkler wire, low-voltage landscape lighting, and underground low-energy circuit cables

7.1 General
Clause 7 applies to wires and cables for use in golf course sprinkler systems (GCS), lawn sprinkler systems (LSS), low voltage landscape lighting (LVLL), and underground low energy circuits (ULEC), intended for operation at no more than 30 V and rated 60 °C maximum.

7.2 Construction

7.2.1 Conductors

7.2.1.1 Bare copper conductors
Each wire in a bare copper conductor shall comply with the requirements of ASTM B 3.

7.2.1.2 Tin-coated copper conductors
Each wire in a tin-coated copper conductor shall comply with the requirements of ASTM B 33. Sizes 14 AWG, 12 AWG, and 10 AWG stranded conductors may be overcoated with a layer of tin.

7.2.1.3 Sizes
Conductors shall be of a size specified in Table 10.

7.2.1.4 Joint or splice
A joint in a solid conductor or in one of the individual wires of a stranded conductor shall neither increase the diameter nor decrease the strength of the conductor or the individual wire. A joint shall not be made in a stranded conductor as a whole, except that a bunch-stranded conductor as a whole in sizes of No. 10 AWG and smaller, made up of No. 26 AWG or smaller strands, may be brazed or welded, providing the solid section of the conductor does not exceed 13 mm in length and the distance between brazes or welds is a minimum of 1 km. Joints in a compressed or compact conductor should be made prior to compressing or compacting. Joints in the individual wires in a stranded conductor should be staggered by at least two times the lay length (9 AWG and larger).

7.2.2 Insulation

7.2.2.1 General
The insulation on the conductors shall meet the requirements of Clause 7.2.2.2 or 7.2.2.3, as applicable.

7.2.2.2 Polyvinyl chloride (PVC) — All types

Δ **7.2.2.2.1**
The entire length of individual conductors shall be insulated with a PVC thermoplastic material meeting all the requirements of this Standard. The insulation shall be applied directly over the conductor or over the separator if provided, and shall fit tightly thereto. The insulation shall be free of pores, splinters, and other inhomogeneities visible without magnification to normal or corrected-to-normal vision. The physical properties shall meet the requirements specified in Table 11.

7.2.2.2.2
Compliance with the elongation requirement of Clause 7.2.2.2.1 shall be determined in accordance with the apparatus and method specified in the tensile properties and exposure to accelerated aging tests of CSA C22.2 No. 0.3.

Δ **7.2.2.3 Polyethylene (PE)**
Prior to application to the conductors, Types GCS, LSS and ULEC using PE insulation shall meet the requirements of ASTM D 1248, for Type I or II, Class A or B or C, Grade E4 or E5 or E7 or E8 or E11, and Category 4 or 5. After application to the conductor, the PE insulation shall meet the physical and electrical requirements of ASTM D 1351, except that the minimum elongation for Type I — low density PE shall be 350% and for Type II — medium density PE shall be 250%.

7.2.2.4 Thickness of insulation — All types

The minimum average thickness of insulation shall be not less than the values specified in Table 10. The minimum thickness at any point shall be not less than 90% of the minimum average thickness specified in Table 10. Two or three insulated conductors are laid parallel with an interconnecting web. The thickness of the insulation after separation of the multiconductor cable conductors shall not be decreased. Compliance shall be determined in accordance with the thickness test of CAN/CSA-C22.2 No. 2556.

7.2.3 Conductor assembly

Types GCS and LSS in sizes 20 to 16 AWG consisting of two or more conductors shall have the individual insulated conductors twisted (length and direction of lay not specified), except that in the case of a 2-conductor assembly, the individual insulated conductors may be laid parallel. Types LVLL and ULFC in 2- and 3-conductor constructions shall consist of parallel constructions with individual insulated conductors joined by a web or other suitable means.

7.2.4 Jackets — Other than PE (optional)

7.2.4.1

Types GCS and LSS using thermoplastic (other than PE) or thermosetting jackets shall meet the applicable requirements of Clause 7.2.4.1, 7.2.4.2, or 7.2.4.3. Jacket materials shall be compatible with the insulating material. The thickness of the jacket shall be not less than the values specified in Table 10.

7.2.4.2

The physical properties of thermoplastic jackets other than PE shall meet the requirements of Table 12.

7.2.4.3

The physical properties of thermoset jackets shall meet the requirements of Table 12.

7.2.4.4

Compliance with the physical properties requirements of Clauses 7.2.4.2 and 7.2.4.3 shall be determined in accordance with the apparatus and method specified in the tensile properties and exposure to accelerated aging tests of CSA C22.2 No. 0.3.

7.2.5 PE jackets (optional)

Δ #### 7.2.5.1

Types GCS and LSS using PE jackets before application to the conductors, shall meet the requirements of ASTM D 1248 for overall jackets of the following specifications:

(a) Class C;
(b) Type I or II;
(c) Category 4 or 5; and
(d) Grade J1, J3, J4, or J5.

The thickness of the jacket shall be not less than the values specified in Table 10.

7.2.5.2

PE jackets shall have a minimum elongation of 250% for Type II (medium density) and 350% for Type I (low density) PE.

7.3 Marking

7.3.1 Marking on cable

Golf course and lawn sprinkler wire systems and low-voltage landscape lighting and underground low-energy circuit cables shall have durable and distinctive markings on the surface of the insulation or

covering, as applicable, at 1 m intervals, throughout their entire length. The marking on the surface of the wires and cables shall include

(a) manufacturer's name, trade name, or other distinctive marker;
(b) voltage rating (30 V);
(c) type designation;
(d) flame test classification for Types GSC, LSS, and LVLL;
(e) low temperature classification — "–40 °C" (if applicable);
(f) size of conductor;
(g) "DIR-BUR ONLY" or "Direct Burial Only" for Type ULEC;
(h) "SUN LIGHT RESISTANT", "SUN RES", or "SR" for constructions in compliance with Clause 7.4.4; and
(i) optional — "DIRECT BURIAL" or "DIR-BUR" (jacketed types GCS & LSS, 9-2 AWG types GCS & LSS, and type LVLL.)

7.3.2 Marking on coils, spools, and reels

Each coil, spool, or reel of wire and cable shall be tagged or marked to plainly and legibly indicate the following:

(a) manufacturer's name or marker;
(b) date of manufacture;
Note: *As an alternative, the date of manufacture may be printed on the surface of the product in the same manner and location as specified in Clause 7.3.1.*
(c) type designation;
(d) size of conductor;
(e) maximum voltage (30 V);
(f) "To be used for direct burial only" for Type ULEC; and
(g) "Caution: Do not use as a building wire".

7.4 Tests

7.4.1 Dielectric strength — PVC insulated types

7.4.1.1

A finished wire or cable shall be immersed in water at room temperature for not less than 6 h. It shall then be subjected to an application of an ac test voltage of 1000 V while immersed. The insulation shall be such that a finished wire or cable will withstand the application of the test voltage without breakdown, for a period of 1 min.

7.4.1.2

Compliance with the dielectric strength test in Clause 7.4.1.1 shall be determined in accordance with the apparatus and method of the dielectric voltage-withstand test of CAN/CSA-C22.2 No. 2556.

7.4.2 Insulation resistance in water at 15 °C — PVC insulated types

7.4.2.1

Immediately following the dielectric strength test specified in Clause 7.4.1, the insulation resistance shall be measured at the prevailing water temperature and corrected to 15 °C. For sizes 14 AWG and smaller, the insulation resistance shall be not less than 27 Giga ohm meters (G.Ω.m). For sizes 12 AWG and larger, the insulation resistance shall be as specified in CSA C22.2 No. 75 for Type TW.

7.4.2.2

Compliance with the insulation resistance test in Clause 7.4.2.1 shall be determined in accordance with the apparatus and method of the short-term insulation resistance test (method 1) of CAN/CSA-C22.2 No. 2556.

Table 7
Mandrel diameter for cold bend test
(See Clauses 4.4.4.2.1 and 4.4.4.6.1.)

Overall diameter of finished cable, * mm	Diameter of mandrel, mm
0–5.08	12.7
5.09–6.35	25.4
6.36–7.62	31.8
7.63–9.53	38.1
9.54–10.8	44.5
10.9–12.7	50.8

**For flat twin cable, the minor dimension shall be used, and the cable shall be wound flatwise around the mandrel.*

Table 8
Thickness of insulation and web on low-energy control cable
(See Clause 5.2.2.2.)

Thickness of insulation, mm	Average	0.76
	Minimum at any point before separation	0.68
	Minimum at tear after separation	0.33
Thickness of web, mm	Minimum at any point	1.14

Table 9
Physical properties of insulation on low-energy control cables
(See Clause 5.4.2.1.1.)

	Test		Requirement
Before aging	Elongation, minimum increase in distance between 50 mm gauge marks, %		100
	Minimum tensile strength, MPa		10.3
After aging	Air-oven test	Oven temperature	121 ± 1 °C
		Time	21 d
		Minimum % of results obtained before aging	Elongation 65
			Tensile strength 75
After oil immersion*	Oil immersion test	Oil temperature	24 ± 8 °C
		Time	21 d
		Minimum % of results obtained before immersion	Elongation 65
			Tensile strength 75

**IRM 902 oil.*

Table 10
Construction
(See Clauses 1.2, 7.2.1.3, 7.2.2.4, 7.2.4.1, and 7.2.5.1.)

					Insulation		Jacket		
Description	Type	Maximum temperature rating	Maximum voltage rating	Size range — AWG	Class	Minimum average thickness, mm	Class	Minimum average thickness, mm	Constructions
Golf course and lawn sprinkler wire	GCS or LSS	60 °C	30 V	20–16 14 12–10 9, 8 6–2	PVC or PE	0.38 0.51 0.76 1.14 1.52	Thermoset or thermo-plastic	0.76 (0.61 minimum at any point) Optional	Sizes 20 to 16 AWG – One or more twisted or 2 conductor parallel Sizes 14 AWG and larger – single conductor
Low-voltage landscape lighting	LVLL	60 °C	30 V	18–10 9, 8	PVC	1.14 1.52	N/A		Single and 2 or 3 conductor parallel
Underground low-energy circuits	ULEC	60 °C	30 V	18–10 9, 8	PVC or PE	1.14 1.52	N/A		Single and 2 or 3 conductor parallel No flame classification required

Update No. 1
C22.2 No. 35-09
May 2010

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Title: *Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable —* originally published September 2009

The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

Revised	Table 10
New	None
Deleted	None

CSA C22.2 No. 35-09 originally consisted of **34 pages** (ix preliminary and 25 text), each dated **September 2009**. It now consists of the following pages:

September 2009	iii–ix, 1–22, and 25
May 2010	23 and 24

- Update your copy by inserting these revised pages.
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Mandrel diameter for cold bend test
(See Clauses 4.4.4.2.1 and 4.4.4.6.1.)

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9.54–10.8	44.5
10.9–12.7	50.8

**For flat twin cable, the minor dimension shall be used, and the cable shall be wound flatwise around the mandrel.*

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Thickness of web, mm	Minimum at any point	1.14

Table 9
Physical properties of insulation on low-energy control cables
(See Clause 5.4.2.1.1.)

	Test		Requirement
Before aging	Elongation, minimum increase in distance between 50 mm gauge marks, %		100
	Minimum tensile strength, MPa		10.3
After aging	Air-oven test	Oven temperature	121 ± 1 °C
		Time	21 d
		Minimum % of results obtained before aging	Elongation 65
			Tensile strength 75
After oil immersion*	Oil immersion test	Oil temperature	24 ± 8 °C
		Time	21 d
		Minimum % of results obtained before immersion	Elongation 65
			Tensile strength 75

**IRM 902 oil.*

Table 10
Construction

(See Clauses 1.2, 7.2.1.3, 7.2.2.4, and 7.2.4.1.)

					Insulation		Jacket		
Description	**Type**	**Maximum temperature rating**	**Maximum voltage rating**	**Size range — AWG**	**Class**	**Minimum average thickness, mm**	**Class**	**Minimum average thickness, mm**	**Constructions**
Golf course and lawn sprinkler wire	GCS or LSS	60 °C	30 V	20–16 14 12–10 9, 8 6–2	PVC or PE	0.38 0.51 0.76 1.14 1.52	Thermoset or thermo-plastic	0.76 (0.61 minimum at any point) Optional	Sizes 20 to 16 AWG – One or more twisted or 2 conductor parallel Sizes 14 AWG and larger – single conductor
Low-voltage landscape lighting	LVLL	60 °C	30 V	18–10 9, 8	PVC	1.14 1.52	N/A		Single and 2 or 3 conductor parallel Flame classification required — FT2
Underground low-energy circuits	ULEC	60 °C	30 V	18–10 9, 8	PVC	1.14 1.52	N/A		Single and 2 or 3 conductor parallel No flame classification required

Standards Update Service

CSA C22.2 No. 35:09
September 2009

Title: *Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable*

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Contents

Tables

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Preface

This is the sixth edition of CSA C22.2 No. 35, *Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable*, one of a series of Standards issued by the Canadian Standards Association under the *Canadian Electrical Code, Part II*. It supersedes the previous editions, published in 1987, 1963, 1947, 1940, and 1937.

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

This Standard was prepared by the Integrated Committee on Control, Instrument, Communication, and Marine Cables, under the jurisdiction of the Technical Committee on Wiring Products and the Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the Technical Committee.

Interpretations: The Strategic Steering Committee on Requirements for Electrical Safety has provided the following direction for the interpretation of standards under its jurisdiction: "The literal text shall be used in judging compliance of products with the safety requirements of this Standard. When the literal text cannot be applied to the product, such as for new materials or construction, and when a relevant committee interpretation has not already been published, CSA's procedures for interpretation shall be followed to determine the intended safety principle".

September 2009

Notes:

(1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

(2) *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.*

(3) *This publication was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this publication.*

(4) *CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee.*

(5) *All enquiries regarding this Standard, including requests for interpretation, should be addressed to Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6.*

Requests for interpretation should

(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;

(b) provide an explanation of circumstances surrounding the actual field condition; and

(c) be phrased where possible to permit a specific "yes" or "no" answer.

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are published in CSA's periodical* Info Update*, which is available on the CSA Web site at www.csa.ca.*

C22.2 No. 35-09
Extra-low-voltage control circuit cable, low-energy control cable, and extra-low-voltage control cable

1 Scope

1.1
This Standard specifies requirements for the following types of control cables, rated 30 V maximum, intended for use in extra-low-voltage control circuits in accordance with the rules of the *Canadian Electrical Code, Part I*:

(a) Type LVT extra-low-voltage control circuit cables, rated 60 °C maximum;
(b) low-energy control cable, rated 105 °C maximum;
(c) Type ELC extra-low-voltage control cable, rated 60 °C maximum; and
(d) golf course and lawn sprinkler wire, low-voltage, and low-energy circuit cables, rated 60 °C maximum.

1.2
Tables 1 and 10 provide summaries of the types of cables covered by this Standard.

1.3
In CSA Standards, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; "may" is used to express an option or that which is permissible within the limits of the standard; and "can" is used to express possibility or capability. Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material. Notes to tables and figures are considered part of the table or figure and may be written as requirements. Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications
This Standard makes reference to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

CSA (Canadian Standards Association)
C22.1-09
Canadian Electrical Code, Part I

CAN/CSA-C22.2 No. 0-M91 (R2006)
General Requirements — Canadian Electrical Code, Part II

C22.2 No. 0.3 (under development)
Test methods for electrical wires and cables