CANADIAN STANDARDS ASSOCIATION

C22.2 No. 96-09

Portable power cables

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CANADIAN STANDARDS ASSOCIATION

Update No. 1
C22.2 No. 96-09
September 2009

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Title: *Portable power cables* — originally published March 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	Clauses 13.3.1(h) and 14.5.4.1 and Tables 2B and 3
New	None
Deleted	None

CSA C22.2 No. 96-09 originally consisted of **112 pages** (xii preliminary and 100 text), each dated **March 2009**. It now consists of the following pages:

March 2009	iii–xii, 1–46, 49–54, 57–66, and 71–100
September 2009	47, 48, 55, 56, and 67–70

- Update your copy by inserting these revised pages.
- Keep the pages you remove for reference.

13.3 Marking

13.3.1 Product marking

Finished cable shall be surface-marked by ink-printing or shall have markings impressed in the jacket or raised letters and figures on an impressed background, at intervals not exceeding 1 m, with the following information:

(a) name of the manufacturer or a symbol by which the cable can be identified as the product of a particular factory;
(b) "FT1" or "FT4" — optional for cables meeting the requirements of Clause 13.4.6;
(c) voltage rating "600 V";
(d) temperature rating "60 °C", "75 °C", "80 °C", "90 °C", or "105 °C", as applicable;
(e) number and size of conductors;
(f) type designation "Festoon Cable";
(g) "Sun Res" or "Sunlight Resistant" for cables complying with the weather resistance test;
Δ (h) "W60C" or "W75C", for 60 °C or 75 °C, respectively, as applicable, for cables meeting the requirements of Clauses 13.4.8 and 13.4.9; and
(i) "–40C" or, alternatively, "–50C", "–55C", or another applicable low-temperature marking lower than –30 °C (mandatory test) for cables meeting the requirements of the cold bend test in Clause 13.4.2.
Note: *The word "MINUS" may be substituted for the minus sign ("–") in the temperature markings specified in Item (i).*

13.3.2 Package marking

Each package shall be marked with the following information:

(a) manufacturer's identification (name or trademark);
(b) date of manufacture (a code may be used);
(c) number and size of conductors;
(d) temperature rating "60 °C", "75 °C", "80 °C", "90 °C", or "105 °C", as applicable;
(e) type designation "Festoon Cable"; and
(f) voltage rating "600 V".

13.3.3 Alternative marking

As an alternative to the marking required by Clause 13.3.2(b), the month and year of manufacture may be included in the product markings specified in Clause 13.3.1. A code may be used for this alternative marking.

13.4 Tests

13.4.1 General

The completed cable shall meet the physical and aging test requirements for jacket and insulation compounds specified in Tables 33 and 34, respectively.

13.4.2 Cold bend test

The cold bend properties shall be in accordance with Clause 5.5.10, except that the mandrel diameter shall be three times the minor dimension of the cable. The test shall be performed at –30 °C or at the temperature marked on the cable.

13.4.3 Deformation

Jacket and insulation compounds specified in Table 35 shall not deform more than 50% when subjected to the deformation test of CAN/CSA-C22.2 No. 2556. The test temperature and test loads shall be as specified in Table 35.

13.4.4 Heat shock (applicable to types with TPE and PVC jackets)

The heat shock test shall be performed on the completed cable as specified in the heat shock test of CAN/CSA-C22.2 No. 2556. The diameter of the mandrel shall be equal to the minor dimension of the cable. The conditioning period shall be 1 h at a temperature specified in Table 33.

13.4.5 FT1 flame test — Mandatory

The flame test shall be in accordance with Clause 5.5.7.

13.4.6 FT4 flame test — Optional

The flame test shall be in accordance with Clause 10.3.1.3.

13.4.7 Spark test

The finished cable shall withstand a spark test voltage of 6 kV ac (rms). The spark test shall be performed in accordance with the spark test of CAN/CSA-C22.2 No. 2556.

13.4.8 Insulation resistance at elevated temperature — Optional

13.4.8.1

For constructions with PVC insulated conductors, the individual insulated conductor, prior to the application of the overall jacket, shall meet the requirements of Clause 5.3 of CAN/CSA-C22.2 No. 75 for Types TW or TW75, rated 60 °C or 75 °C, respectively. For constructions with EPDM insulated conductors, the individual insulated conductor, prior to the application of the overall jacket, shall meet the requirements of Clause 5.4 of CAN/CSA-C22.2 No. 38 for Types RW75, RW90, rated 75 °C or 90 °C, respectively.

13.4.8.2

The insulation resistance test shall be performed in accordance with the long-term insulation resistance test (method 1) of CAN/CSA-C22.2 No. 2556.

13.4.9 Permittivity — Optional

The permittivity shall be not more than 9.0 after 24 h immersion when tested in accordance with the capacitance and relative permittivity test of CAN/CSA-C22.2 No. 2556. In addition, the capacitance shall not increase more than 10% after 14 days, and the 14-day result shall not be greater than 3% of the 7-day result and shall be measured on each of the two outside insulated conductors of the product.

13.4.10 Weather resistance test

13.4.10.1

The jacket shall show no cracks when a specimen of completed cable is subjected to the cold bend test specified in Clause 13.4.2 following exposure for 720 h in a weatherometer.

13.4.10.2

Compliance with Clause 13.4.10.1 shall be determined in accordance with the apparatus and method specified in the weather resistance test of CSA C22.2 No. 0.3.

14.3.10 Overall diameters

The nominal overall diameters of completed cables shall be in accordance with Table 2B. The tolerance for overall diameters shall be +8% and –5%. The +8% tolerance shall not apply in specific applications where a larger diameter is required; under such a condition, the package marking shall comply with Clause 5.4.2(h).

14.4 Marking

14.4.1 Product marking

Finished cable shall be surface-marked, or in mining applications shall have markings impressed in the jacket or raised letters and figures on an impressed background, at intervals not exceeding 1 m, with the following information:

(a) name of the manufacturer or a symbol by which the cable can be identified as the product of a particular factory;
(b) type designation;
(c) conductor size (AWG or kcmil);
(d) voltage rating;
(e) "FT1";
(f) "FT5";
(g) "FT4" for cables complying with Clause 14.5.10;
(h) "–40 °C" or, alternatively, another applicable low-temperature marking lower than –40 °C if the requirements for cold bend test and low temperature impact test at the marking temperature are met;
Note: *The word "MINUS" may be substituted for the minus sign ("–") in the temperature markings specified in Item (h).*
(i) "EXTENSIBLE GROUND-CHECK" for cables with extensible ground-check(s) — optional;
(j) "SUNLIGHT RESISTANT" — optional; and
(k) "TC" if it meets the requirements of FT1 and FT4 — optional.

14.4.2 Package marking

Each package shall be marked with the following information:

(a) name of the manufacturer;
(b) type designation;
(c) number and size of power conductors;
(d) voltage rating;
(e) date of manufacture (a code may be used); and
(f) "EXTENSIBLE GROUND-CHECK" for cables with extensible ground-check(s) — optional.

14.4.3 Alternative marking

As an alternative to the marking required by Clause 14.4.2(e), the month and year of manufacture may be included in the product markings specified in Clause 14.4.1. A code may be used for this alternative marking.

14.5 Tests

14.5.1 General

The completed cable shall meet the physical and aging test requirements for insulation and jacket compounds specified in Clauses 5.3.4.1 and 5.3.9.2.1, respectively.

14.5.2 Insulation deformation test

Insulation deformation shall be in accordance with Clause 5.5.2.

14.5.3 Spark test — Constructions up to 2 kV

For factory testing, the wire shall be spark-tested in accordance with the spark test of CAN/CSA-C22.2 No. 2556. The spark voltage shall be applied to 100% of the wire production prior to cabling and be no less than

(a) 12.5 kV (rms) for No. 8 AWG to 2 AWG;
(b) 15 kV (rms) for No. 1 AWG to 4/0 AWG;
(c) 17.5 kV for 250 kcmil to 500 kcmil; and
(d) 22.5 kV for 501 kcmil to 1000 kcmil.

14.5.4 Voltage withstand test

Δ **14.5.4.1**

The insulated power conductors in each length of completed cable shall withstand the voltage specified in Table 2B for a period of 5 min. This test is not required if the test in Clause 14.5.3 is performed.

14.5.4.2

A voltage test on the insulated ground-check conductor(s) in the completed cable shall be made between the ground-check conductor and the bonding (grounding) conductors, shields, and power conductors, by applying an ac voltage of 3 kV for 15 s. The bonding (grounding) conductors, shields, and power conductors shall be connected together. The insulation resistance test is not required.

14.5.4.3

Compliance with Clauses 5.5.3.1 and 5.5.3.2 shall be determined in accordance with the dielectric voltage withstand test method [method one (type non-shielded) or method 2 (type shielded)] and apparatus of CAN/CSA-C22.2 No. 2556. For non-shielded types, this test shall be performed after not less than six hours immersion in water.

14.5.5 Insulation resistance test for power conductors

Insulation resistance shall be in accordance with Clause 5.5.4.

14.5.6 Test for permittivity and power factor of insulated power conductors

The permittivity and power factor of insulated power conductors shall be in accordance with Clause 5.5.4.

14.5.7 Test for accelerated water absorption of insulated power conductors

The accelerated water absorption of insulated power conductors shall be in accordance with Clause 5.5.6.

14.5.8 FT1 flame test

The flame test shall be in accordance with Clause 5.5.7.

14.5.9 FT3 flame test for cables for use in underground workings and mines

Flame tests for cables for use in underground workings and mines shall be in accordance with Clause 5.5.8.

14.5.10 FT4 flame test (optional)

When tested in accordance with the vertical flame tray test (method 2 — FT4) of CAN/CSA-C22.2 No. 2556, the cable shall not exhibit a char length in excess of 1.5 m. Cables meeting the requirements of the FT4 test need not be tested to Clause 14.5.8.

Table 2A (Concluded)

Power conductor size, AWG or kcmil	Insulation thickness,* mm	Ground-check size, SHD-GC AWG	Jacket thickness, mm	Overall diameter, mm	Test voltage, kV ac
		25 kV			
1	7.49	8	3.97	69.7	52.0
1/0	7.49	8	3.97	71.7	52.0
2/0	7.49	8	4.14	75.5	52.0
3/0	7.49	8	4.14	78.5	52.0
4/0	7.49	8	4.49	83.0	52.0
250	7.49	8	4.49	84.7	52.0
350	7.49	8	4.49	91.3	52.0
500	7.49	8	4.72	101.7	52.0

**The insulation thickness may be reduced by* 0.89 mm *if a* 0.89 mm *extruded insulated shield is applied to cables rated* 8, 15, *and* 25 kV.

Table 2B
Three-conductor round, Types VFD and VFD-BGC cables rated 2 kV and 5 kV

(See Clauses 14.3.4.2, 14.3.9.6, 14.3.9.8.5, 14.3.10, and 14.5.4.1.)

Power conductor size, AWG or kcmil	Insulation thickness, mm	Jacket thickness, mm	Overall diameter, mm	Test voltage, kV, ac
		2 kV		
6	1.77	3.94	31.0	7
4	1.77	3.94	33.7	7
3	1.77	3.94	34.6	7
2	1.77	3.94	35.6	7
1	2.03	4.32	41.6	8
*1/0	2.03	4.32	44.2	8
*2/0	2.03	4.32	46.0	8
*3/0	2.03	4.32	49.0	8
*4/0	2.03	4.83	53.2	8
*250	2.41	4.83	59.0	9.5
*300	2.41	4.83	62.5	9.5
*350	2.41	5.59	67.0	9.5
*400	2.41	5.59	70.2	9.5
*450	2.41	5.59	72.6	9.5
*500	2.41	5.59	75.0	9.5
*600	2.41	6.35	82.7	9.5
*750	2.41	6.73	90.6	9.5
*800	2.41	7.11	93.4	9.5
*900	2.41	8.38	99.8	9.5
*1000	2.41	8.38	104.7	9.5
		5 kV		
6	2.79	3.94	34.6	13
4	2.79	3.94	42.1	13
3	2.79	3.94	43.3	13
2	2.79	3.94	46.3	13
1	2.79	4.32	48.7	13
*1/0	2.79	4.32	51.0	13
*2/0	2.79	4.83	54.5	13
*3/0	2.79	4.83	57.5	13
*4/0	2.79	5.53	62.6	13
*250	3.04	5.53	68.1	14.5
*300	3.04	5.59	69.3	14.5
*350	3.04	5.59	73.0	14.5
Δ *400	3.04	5.59	75.5	14.5
Δ *450	3.04	5.59	78.6	14.5
*500	3.04	5.59	84.3	14.5
*600	3.04	7.11	87.5	14.5
*750	3.04	7.87	95.0	14.5
*800	3.04	7.87	98.1	14.5
*900	3.04	8.38	104.6	14.5
*1000	3.04	8.38	109.4	14.5

(Continued)

Table 2B (Concluded)

Power conductor size, AWG or kcmil	Insulation thickness, mm	Jacket thickness, mm	Overall diameter, mm	Test voltage, kV ac
		8 kV		
4	3.81	4.32	49.0	23
3	3.81	4.32	52.0	23
2	3.81	4.69	54.4	23
*1	3.81	4.69	57.2	23
*1/0	3.81	4.83	59.8	23
*2/0	3.81	4.83	63.0	23
*3/0	3.81	5.53	66.7	23
*4/0	3.81	5.53	70.2	23
*250	3.81	5.59	72.1	23
*350	3.81	5.97	79.4	23
*500	3.81	7.11	91.0	23
*750	3.81	8.38	104.2	23
		15 kV		
4	5.33	4.69	54.1	35
3	5.33	4.69	56.0	35
*2	5.33	4.83	61.2	35
*1	5.33	4.83	63.4	35
*1/0	5.33	5.53	67.1	35
*2/0	5.33	5.53	69.7	35
*3/0	5.33	5.59	73.6	35
*4/0	5.33	5.59	77.5	35
*250	5.33	5.97	80.5	35
*350	5.33	6.35	87.9	35
*500	5.33	7.87	98.6	35
*750	5.33	8.76	111.2	35

**These conductor sizes will typically accommodate a centre ground-check conductor.*

Δ

Table 3
Conductor stranding for cables rated over 2 kV

(See Clauses 5.3.1.1.2, 5.3.2.2, 14.3.1.1.2, and 14.3.2.2.)

		SHD-GC		SHD-BGC	
		Number of power conductors	3	Number of power conductors	3
		Number of bonding conductors	2	Number of bonding conductors	3
Power conductors size, AWG or kcmil	Minimum number of wires or conductors	Size of individual bonding (grounding) conductors, AWG* or kcmil	Minimum number of wires per conductor	Size of individual bonding (grounding) conductors, AWG*	Minimum number of wires per conductor
6	49	10	19	12	19
4	49	9	49	10	19
3	49	8	49	9	49
2	133	7	49	8	49
1	133	6	133	7	49
1/0	133	5	133	6	133
2/0	133	4	133	5	133
3/0	259	3	133	4	133
4/0	259	2	133	3	133
250	259	1	133	3	133
300	259	1/0	259	2	259
350	259	1/0	259	1	259
400	259	2/0	259	1	259
450	259	3/0	259	1/0	259
500	259	3/0	259	1/0	259
750	427	300	259	3/0	259
1000	427	350	259	4/0	259

**AWG sizes are nominal only. Required minimum total bonding (grounding) conductor area shall be 60% of the minimum conductor area of a power conductor.*

CSA Standards Update Service

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Preface

This is the ninth edition of CSA C22.2 No. 96, *Portable power cables,* 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 2003, 1998, 1992, 1989, 1974, 1964, 1958, and 1951.

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

This Standard was prepared by the Subcommittee on Portable and Mine Power 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."

March 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. 96-09
Portable power cables

1 Scope

1.1
This Standard specifies construction and testing requirements for portable power cables normally used in applications where the cables are subject to frequent flexing and where installation is in accordance with CAN/CSA-M421 and/or the *Canadian Electrical Code, Part I*.

1.2
The cable constructions specified in Clauses 5 to 9 and Clauses 12 to 15 of this Standard are suitable for use at a maximum conductor temperature of 90 °C under normal operating conditions in wet or dry locations, outdoors or in underground mines, and in rugged environments. The special cable constructions described in Clauses 10 and 11 are suitable for use at a maximum conductor temperature of 105 °C.

1.3
This Standard does not specify all types, sizes, and voltage ratings of portable power cables that can be required for particular applications.

1.4
This Standard specifies the following categories of cables:

Clause	Category
5	Thermoset and PUR multiconductor round cables for mining and general applications rated over 2 kV and up to 25 kV
6	Thermoset and PUR multiconductor round cables for mining and general applications rated up to 2 kV
7	Thermoset and PUR single-conductor cables for mining and general applications rated up to 35 kV
8	Thermoset two- and three-conductor flat cables for mining and general applications rated up to 2 kV
9	Thermoset three-conductor round cables with a central bonding (grounding) conductor for underground coal mining applications rated up to 5 kV
10	Arc-welding cable
11	600 V single-conductor portable power cable
12	Single and multiconductor PPC cables for general applications rated up to 2 kV
13	Flexible cable for use with cranes and hoists rated 600 V (festoon cable)
14	Variable frequency drive cable three conductor, round, or mining and general applications up to 15 kV
15	DLO cable, single conductor used for portable and general applications up to 2 kV

1.5
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.

1.6
The values given in SI (metric) units are the standard. The values given in parentheses are for information only.

2 Reference publications
This Standard refers 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. 0.3-01 (2005)
Test methods for electrical wires and cables

CAN/CSA-C22.2 No. 38-05
Thermoset-insulated wires and cables

CAN/CSA-C22.2 No. 75-08
Thermoplastic-insulated wires and cables

CAN/CSA-C22.2 No. 2556-07
Wire and cable test methods

C68.10-08
Shielded power cables for commercial and industrial applications, 5–46 kV

CAN/CSA-M421-00 (R2007)
Use of electricity in mines

ASTM (American Society for Testing and Materials)
B 3-01 (2007)
Standard Specification for Soft or Annealed Copper Wire

B 33-04
Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes