

# Nonmetallic sheathed cable



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## **C22.2 No. 48-09**

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<b>New</b>	None
<b>Deleted</b>	Clause 7.5.7

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### 7.5.2 Flame (FT1 test)

A specimen of finished cable shall not burn more than 25% of the indicator, nor continue to burn for more than 1 min, when tested in accordance with the burning characteristics test (FT1) of CAN/CSA-C22.2 No. 2556.

### 7.5.3 Heat shock

#### 7.5.3.1

A jacket shall show no cracks after a specimen of finished cable has been wound around a mandrel as specified in Items (a) or (b) and been conditioned for 1 h at a temperature of  $121 \pm 2$  °C, for Type NMWU cable, and  $131 \pm 2$  °C for Type NMD90.

- (a) Cables having two conductors laid parallel shall be wound, flatwise, six turns around a mandrel having a diameter four times the minor axis of the cable.
- (b) Cables having three or four conductors shall be wound six turns around a mandrel having a diameter six times the diameter of the cable.

#### 7.5.3.2

Compliance with the requirements of Clause 7.5.3.1 shall be determined in accordance with the heat shock test of CAN/CSA-C22.2 No. 2556.

### 7.5.4 Abnormal low-temperature impact

#### 7.5.4.1

The jacket and the insulation on the individual conductors of finished two-conductor parallel cable shall not crack or rupture when specimens are subjected to an impact of 12.2 J at a temperature of  $-25 \pm 1$  °C or  $-40 \pm 1$  °C, as applicable, after having been exposed to that temperature for a period of 4 h. Following the test, the nylon protective covering, if applicable, shall remain intact after removal of the cable jacket. Cracks in the nylon covering, if applicable, shall not be considered a failure unless the length of the longest single crack (and not the sum of crack lengths) exceeds 30 mm or if a particle of the protective covering, visible with normal or corrected to normal vision, falls off.

Ten specimens shall be impacted and not more than two of the specimens shall be adversely affected.

#### 7.5.4.2

Compliance of cable with the requirements of Clause 7.5.4.1 shall be determined in accordance with the cold impact test of CAN/CSA-C22.2 No. 2556.

### 7.5.5 Tensile strength and elongation

#### 7.5.5.1

All cables shall be capable of withstanding the application of a tension of 1335 N for a period of 1 min without fracturing or opening up at any point and without showing a permanent elongation of more than 76 mm in a 915 mm specimen.

#### 7.5.5.2

Compliance of cable with the requirements of Clause 7.5.5.1 shall be determined in accordance with the strength and elongation of cable in tension test of CSA C22.2 No. 0.3.

## 7.5.6 Overload current

### 7.5.6.1

A specimen of two-conductor No. 14 AWG copper or No. 12 AWG aluminum cable enclosed in thermal insulation shall be capable of withstanding without breakdown, for a period of 1 min, the application of an ac voltage of 1500 V (or 4500 V dc), after having been subjected to a current of  $40 \pm 0.5$  A for a period of 15 min. The cable, while still in the test position, shall be allowed to cool for at least 2 h, and then be subjected to an ac dielectric strength test at 1500 V rms (or 4500 V dc) for a period of 1 min. The voltage shall be applied between the insulated conductors, and between the insulated conductors and the uninsulated bonding conductor. There shall be no dielectric breakdown.

### 7.5.6.2

Compliance of cable with the requirements of Clause 7.5.6.1 shall be determined in accordance with the apparatus and method specified in the overload test (method no. 3) of CSA C22.2 No. 0.3.

Δ 7.5.7 — Deleted

## 7.5.8 Dry dielectric strength

### 7.5.8.1

A specimen of cable shall be capable of withstanding without breakdown, for a period of 5 s, an ac voltage of 5000 V or dc voltage of 15 000 V. There shall be no dielectric breakdown.

### 7.5.8.2

Compliance of the cable with the requirements of Clause 7.5.8.1 shall be determined in accordance with the dielectric strength test (method No. 1) specified in CSA C22.2 No. 0.3, except that the voltage shall be increased to 100% of the required level in less than 1 s. During the voltage test, the bonding conductor shall be connected to the grounded side of the test circuit.

## 7.5.9 Continuity of conductors

### 7.5.9.1

The conductors in every coil of finished cable shall be continuous.

Δ

**Table 1 (Continued)**

		Type designation		NMWU
		NMD90 with protective covering	NMD90 with R90 (XLPE) conductors	
<b>Construction and test requirements</b>				
Maximum working temperature, °C		90	90	60
Maximum working voltage, V		300	300	300
Cable jacket		5.8	5.8	5.8
Conductor coding		5.5	5.5	5.5
Marking		6	6	6
Properties and Tests	Conductors	7.1	7.1	7.1
	Insulation	7.2	7.2	5.3.2
	Insulated conductors	7.3	7.3	7.3
	Properties of jackets	7.4	7.4	7.4
	Finished cable	7.5	7.5	7.5
	Cold bend	7.5.1	7.5.1	7.5.1
	Flame	7.5.2	7.5.2	7.5.2
	Heat shock	7.5.3	7.5.3	7.5.3
	Abnormal low-temperature impact	7.5.4	7.5.4	7.5.4
	Tensile strength and elongation of conductors	5.2.1	5.2.1	5.2.1
	Overload current	7.5.6	7.5.6	7.5.6
	Dry dielectric strength	7.5.8	7.5.8	7.5.8

(Continued)

**Table 1 (Concluded)**

Construction and test requirements	Type designation		
	NMD90 with protective covering	NMD90 with R90 (XLPE) conductors	NMWU
Continuity of conductors	7.5.9	7.5.9	7.5.9
Voltage test	7.5.10	7.5.10	7.5.10
Spark test	7.5.11	7.5.11	7.5.11
High-current heat cycling	7.5.12	7.5.12	7.5.12
Cutting	7.5.13	7.5.13	n/a
Crushing	7.5.14	7.5.14	n/a
Impact at room temperature	7.5.15	7.5.15	n/a
Weather resistance	n/a	n/a	7.5.16

# **Update No. 1**

## **C22.2 No.48-09**

### **September 2009**

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<b>Revised</b>	Clauses 5.2.1 and 7.5.8.2
<b>New</b>	None
<b>Deleted</b>	None

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# C22.2 No. 48-09

## ***Nonmetallic sheathed cable***

### **1 Scope**

#### **1.1**

This Standard applies to nonmetallic sheathed cables intended for use on systems having a nominal voltage of 300 V and less, in accordance with the rules of the *Canadian Electrical Code, Part I*.

#### **1.2**

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 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 (R2005)

*Test methods for electrical wires and cables*

CAN/CSA-C22.2 No. 38-05

*Thermoset-insulated wires and cables*

C22.2 No. 42-99 (R2004)

*General use receptacles, attachment plugs and similar wiring devices.*

C22.2 No. 75-08

*Thermoplastic-insulated wires and cables*

CAN/CSA-C22.2 No. 239-97 (R2006)

*Control and instrumentation cables*

CAN/CSA-C22.2 No. 2556-07

*Wire and cable test methods*

**ASTM International (American Society for Testing and Materials)**

B 800-05

*Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes — Annealed and Intermediate Tempers*

### 3 Definitions

The following definitions apply in this Standard:

**Aluminum conductor material (ACM)** — AA 8000 series aluminum alloy conductor in accordance with the physical and electrical requirements of ASTM B 800.

**Combination unilay stranding** — a central core wire surrounded by a layer of six helically laid wires of the same diameter as the core wire, with a helically laid outer layer containing six smaller wires alternated between six wires of the same diameter as the wires in the layer underneath. Both layers have a common length and direction of lay.

**Master reel** — a reel that contains a single length of finished cable that is intended to be cut into shorter lengths for shipping.

**Nonmetallic sheathed cable** — cable with an assembly of two, three, or four insulated conductors without metallic coverings and having an outer covering of nonmetallic composition.

**Thermoplastic** — material that can repeatedly be softened by heating and hardened by cooling through a temperature range characteristic of the material, and that in the softened state can be shaped through the application of force.

**Thermoset** — a cured insulating (or jacketing) compound that will not soften and flow on subsequent heating.

### 4 General requirements

General requirements applicable to this Standard are given in CAN/CSA-C22.2 No. 0.

### 5 Construction

#### 5.1 General

Nonmetallic sheathed cables covered by this Standard are listed in Table 1, and each type of cable shall comply with the requirements for construction details and test performance that apply to that type.

#### 5.2 Conductors

##### Δ 5.2.1

Conductors shall be soft copper or ACM in compliance with the requirements of CSA C22.2 No. 75. The various conductor sizes, conductor types (solid or stranded), and conductor materials that may be used shall be as specified in Table 2. All conductors in the cable shall be of the same metal.

### **7.5.2 Flame (FT1 test)**

A specimen of finished cable shall not burn more than 25% of the indicator, nor continue to burn for more than 1 min, when tested in accordance with the burning characteristics test (FT1) of CAN/CSA-C22.2 No. 2556.

### **7.5.3 Heat shock**

#### **7.5.3.1**

A jacket shall show no cracks after a specimen of finished cable has been wound around a mandrel as specified in Items (a) or (b) and been conditioned for 1 h at a temperature of  $121 \pm 2$  °C, for Type NMWU cable, and  $131 \pm 2$  °C for Type NMD90.

- (a) Cables having two conductors laid parallel shall be wound, flatwise, six turns around a mandrel having a diameter four times the minor axis of the cable.
- (b) Cables having three or four conductors shall be wound six turns around a mandrel having a diameter six times the diameter of the cable.

#### **7.5.3.2**

Compliance with the requirements of Clause 7.5.3.1 shall be determined in accordance with the heat shock test of CAN/CSA-C22.2 No. 2556.

### **7.5.4 Abnormal low-temperature impact**

#### **7.5.4.1**

The jacket and the insulation on the individual conductors of finished two-conductor parallel cable shall not crack or rupture when specimens are subjected to an impact of 12.2 J at a temperature of  $-25 \pm 1$  °C or  $-40 \pm 1$  °C, as applicable, after having been exposed to this temperature for a period of 4 h. Following the test, the nylon protective covering, if applicable, shall remain intact after removal of the cable jacket. Cracks in the nylon covering, if applicable, shall not be considered a failure unless the length of the longest single crack (and not the sum of crack lengths) exceeds 30 mm or if a particle of the protective covering, visible with normal or corrected to normal vision, falls off.

Ten specimens shall be impacted and not more than two of the specimens shall be adversely affected.

#### **7.5.4.2**

Compliance of cable with the requirements of Clause 7.5.4.1 shall be determined in accordance with the cold impact test of CAN/CSA-C22.2 No. 2556.

### **7.5.5 Tensile strength and elongation**

#### **7.5.5.1**

All cables shall be capable of withstanding the application of a tension of 1335 N for a period of 1 min without fracturing or opening up at any point and without showing a permanent elongation of more than 76 mm in a 915 mm specimen.

#### **7.5.5.2**

Compliance of cable with the requirements of Clause 7.5.5.1 shall be determined in accordance with the strength and elongation of cable in tension test of CSA C22.2 No. 0.3.

## **7.5.6 Overload current**

### **7.5.6.1**

A specimen of two-conductor No. 14 AWG copper or No. 12 AWG aluminum cable enclosed in thermal insulation shall be capable of withstanding without breakdown, for a period of 1 min, the application of an ac voltage of 1500 V (or 4500 V dc), after having been subjected to a current of  $40 \pm 0.5$  A for a period of 15 min. The cable, while still in the test position, shall be allowed to cool for at least 2 h, and then be subjected to an ac dielectric strength test at 1500 V rms (or 4500 V dc) for a period of 1 min. The voltage shall be applied between the insulated conductors, and between the insulated conductors and the uninsulated bonding conductor. There shall be no dielectric breakdown.

### **7.5.6.2**

Compliance of cable with the requirements of Clause 7.5.6.1 shall be determined in accordance with the apparatus and method specified in the overload test (method no. 3) of CSA C22.2 No. 0.3.

## **7.5.7 Wet dielectric strength**

### **7.5.7.1**

A specimen of cable shall be immersed in water for 1 h and, while still immersed, shall be capable of withstanding without breakdown, for a period of 1 min, an ac voltage of 5000 V (or dc voltage of 15 000 V) applied between

- (a) each insulated conductor and every other insulated conductor and the bonding conductor of the cable; and
- (b) the interconnected insulated conductors and the metal mandrel around which the cable is wrapped.

There shall be no dielectric breakdown.

### **7.5.7.2**

Compliance of the cable with the requirements of Clause 7.5.7.1 shall be determined in accordance with the dielectric strength test (method No. 6) specified in CSA C22.2 No. 0.3. During the voltage test the bonding conductor shall be connected to the grounded side of the test circuit.

## **7.5.8 Dry dielectric strength**

### **7.5.8.1**

A specimen of cable shall be capable of withstanding without breakdown, for a period of 5 s, an ac voltage of 5000 V or dc voltage of 15 000 V. There shall be no dielectric breakdown.

### **Δ 7.5.8.2**

Compliance of the cable with the requirements of Clause 7.5.8.1 shall be determined in accordance with the dielectric strength test (method No. 1) specified in CSA C22.2 No. 0.3, except that the voltage shall be increased to 100% of the required level in less than 1 s. During the voltage test, the bonding conductor shall be connected to the grounded side of the test circuit.

## **7.5.9 Continuity of conductors**

### **7.5.9.1**

The conductors in every coil of finished cable shall be continuous.

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***Nonmetallic sheathed cable***



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# Preface

This is the eighth edition of C22.2 No. 48, *Nonmetallic sheathed 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 1990, 1984, 1976, 1965, 1957, 1951, and 1938.

This Standard specifies requirements for nonmetallic sheathed cables intended for use on systems having a nominal voltage of 300 V and less.

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 Fixed Installation Wires and 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](http://www.csa.ca).



# C22.2 No. 48-09

## ***Nonmetallic sheathed cable***

### **1 Scope**

#### **1.1**

This Standard applies to nonmetallic sheathed cables intended for use on systems having a nominal voltage of 300 V and less, in accordance with the rules of the *Canadian Electrical Code, Part I*.

#### **1.2**

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 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 (R2005)

*Test methods for electrical wires and cables*

CAN/CSA-C22.2 No. 38-05

*Thermoset-insulated wires and cables*

C22.2 No. 42-99 (R2004)

*General use receptacles, attachment plugs and similar wiring devices.*

C22.2 No. 75-08

*Thermoplastic-insulated wires and cables*

CAN/CSA-C22.2 No. 239-97 (R2006)

*Control and instrumentation cables*

CAN/CSA-C22.2 No. 2556-07

*Wire and cable test methods*