

## Equipment and lead wires



# Legal Notice for Standards

Canadian Standards Association (CSA) standards are developed through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

## Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document's fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party's intellectual property rights. CSA does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA makes no representations or warranties regarding this document's compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA is a private not-for-profit company that publishes voluntary standards and related documents. CSA has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

## Intellectual property rights and ownership

As between CSA and the users of this document (whether it be in printed or electronic form), CSA is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA's and/or others' intellectual property and may give rise to a right in CSA and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA reserves all intellectual property rights in this document.

## Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

## Authorized use of this document

This document is being provided by CSA for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.



CANADIAN STANDARDS  
ASSOCIATION

# ***CSA Standards Update Service***

***C22.2 No. 127-09***

***September 2009***

**Title:** *Equipment and lead wires*

**Pagination:** **96 pages** (x preliminary and 86 text), each dated **September 2009**

Automatic notifications about any updates to this publication are available.

- To register for e-mail notifications, and/or to download any existing updates in PDF, enter the Online Store at **www.ShopCSA.ca** and click on **My Account** on the navigation bar.

The **List ID** for this document is **2420245**.

- To receive printed updates, please complete and return the attached card.



Name \_\_\_\_\_

Organization \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

Province/State \_\_\_\_\_

Country \_\_\_\_\_ Postal/Zip Code \_\_\_\_\_

E-mail \_\_\_\_\_

I consent to CSA collecting and using the above information to send me updates relating to this publication.

Visit CSA's policy on privacy at [www.csagroup.org/legal](http://www.csagroup.org/legal) to find out how we protect your personal information.

***C22.2 No. 127-09***

Currently in preview, click buy full version

**ASSOCIATION CANADIENNE DE  
NORMALISATION**

BUREAU CENTRAL DE L'INFORMATION  
5060, SPECTRUM WAY, BUREAU 100  
MISSISSAUGA ON L4W 5N6  
CANADA

**CANADIAN STANDARDS  
ASSOCIATION**

CONSOLIDATED MAILING LIST  
5060 SPECTRUM WAY, SUITE 100  
MISSISSAUGA ON L4W 5N6  
CANADA

Affranchir suffisamment
Place Stamp Here

*CSA Standard*

*C22.2 No. 127-09*  
***Equipment and lead wires***



**CANADIAN STANDARDS  
ASSOCIATION**

®Registered trade-mark of Canadian Standards Association

*Published in September 2009 by Canadian Standards Association  
A not-for-profit private sector organization  
5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6  
1-800-463-6727 • 416-747-4044*

**Visit our Online Store at [www.ShopCSA.ca](http://www.ShopCSA.ca)**



The Canadian Standards Association (CSA) prints its publications on Rolland Enviro100, which contains 100% recycled post-consumer fibre, is EcoLogo and Processed Chlorine Free certified, and was manufactured using biogas energy.

To purchase CSA Standards and related publications, visit CSA's Online Store at [www.ShopCSA.ca](http://www.ShopCSA.ca) or call toll free 1-800-463-6727 or 416-747-4044.

ISBN 978-1-55491-220-9

**Technical Editor:** Leonard Letea

© Canadian Standards Association — 2009

All rights reserved. No part of this publication may be reproduced in any form whatsoever without the prior permission of the publisher.

# Contents

Technical Committee on Wiring Products vii

Integrated Committee on Flexible Cords/Equipment and Appliance Wires viii

Preface x

## 1 Scope 1

## 2 Reference publications 1

## 3 Definitions 2

## 4 General requirements 2

## 5 Construction 2

### 5.1 Conductors 2

#### 5.1.1 Material 2

#### 5.1.2 Coated copper wires 3

#### 5.1.3 Uncoated copper wires 3

#### 5.1.4 Stranding 3

#### 5.1.5 Diameter and area 4

#### 5.1.6 Resistance 4

#### 5.1.7 Joints 4

### 5.2 Separator 4

### 5.3 Insulation 4

#### 5.3.1 General 4

#### 5.3.2 Thickness 4

#### 5.3.3 Braid coating 4

#### 5.3.4 Colour 4

### 5.4 Covering over insulation — All types 5

### 5.5 Shields (optional) 5

### 5.6 Covering over shields 5

### 5.7 Jackets and coverings 5

### 5.8 Multiple-conductor constructions 6

#### 5.8.1 Types 6

#### 5.8.2 Construction 6

## 6 Tests 8

### 6.1 Equipment wires 8

#### 6.1.1 Physical properties of insulation 8

#### 6.1.2 Flame 8

#### 6.1.3 Cold bend 9

#### 6.1.4 Cold bend and dielectric 9

#### 6.1.5 Low temperature impact — Types TXFW and TLW 9

#### 6.1.6 Heat-resistant properties 9

#### 6.1.7 Dielectric strength following temperature conditioning 10

#### 6.1.8 Deformation 10

#### 6.1.9 Dielectric strength after heat deformation — Type GTF 11

#### 6.1.10 Spark — All types 11

#### 6.1.11 Dielectric strength at room temperature 11

#### 6.1.12 Insulation resistance at room temperature 12

- 6.1.13 Dielectric strength at elevated temperature 12
- 6.1.14 Insulation resistance at elevated temperature 12
- 6.1.15 Insulation resistance at 50 °C — Type TXFW 13
- 6.1.16 Dielectric strength on unbent specimen — Type TBS 13
- 6.1.17 Dielectric strength after bending — Type TBS 13
- 6.1.18 Insulating varnish — Types TEW, REW, and TEWN 13
- 6.1.19 Durability of printing 13
- 6.1.20 Resistance to cutting — Type TXFW 14
- 6.1.21 Surface leakage resistance — Type TBS 14
- 6.1.22 Weather resistance — Type TXFW 14
- 6.1.23 Relative permittivity — Type TXFW 14
- 6.2 Lead wires 15
  - 6.2.1 Physical properties of insulations 15
  - 6.2.2 Nylon covering 15
  - 6.2.3 Heat-resistant properties 15
  - 6.2.4 Deformation — Types CL904, CL1051, CL1054, CL1055, CL1056, CL1251, CL1252, CL1253, CL1254, and CL1255 16
  - 6.2.5 Cold bend — All types 17
  - 6.2.6 Flame 17
  - 6.2.7 Burning particles — Types CL1054, CL1055, CL1056, CL1251, CL1252, CL1253, CL1254, CL1255, CL1502, and CL1503 17
  - 6.2.8 Insulating varnish — All types 18
  - 6.2.9 Dielectric strength at rated temperature — Types CL1055, CL1056, CL1251, CL1252, CL1253, CL1254, and CL1255 18
  - 6.2.10 Durability of printing — Types of lead wires with surface ink printing 18
  - 6.2.11 Ozone resistance — Types CL905, CL1055, CL1254, and CL1255 18
  - 6.2.12 Flexibility — Type CL904 wire with an extruded nylon covering 19
  - 6.2.13 Additional requirements for gasoline-vapour-resistant Type CL1251 lead wire 19
  - 6.2.14 Conductor/insulation compatibility of uncoated copper conductors 20
  - 6.2.15 Spark — All types 21
- 6.3 Types GTO and ICS cables 21
  - 6.3.1 Physical properties of insulation 21
  - 6.3.2 Physical properties of jackets 21
  - 6.3.3 Dielectric strength at room temperature — All types 22
  - 6.3.4 Extended voltage application — All types 22
  - 6.3.5 Horizontal flame (FT2) 22
  - 6.3.6 Specific surface resistivity — Types having polyethylene insulation and a polyvinyl chloride jacket, and Type ICS 22
  - 6.3.7 U-bend discharge — All types 23
  - 6.3.8 Abrasion — GTO cables without coverings 23
  - 6.3.9 Dielectric strength after aging — Type ICS 23
  - 6.3.10 Dielectric strength test after oil immersion — Type ICS 23
  - 6.3.11 Swelling — Type ICS 23
  - 6.3.12 Weather (sunlight) resistance — GTO types 24
  - 6.3.13 Spark — All types 24
- 6.4 Electronic wires — Single-conductor thermoplastic types and twin lead wires 24
  - 6.4.1 General 24
  - 6.4.2 Physical properties of insulation 24
  - 6.4.3 Physical properties of jackets 25
  - 6.4.4 Physical properties of overall insulating covering 25
  - 6.4.5 Properties of finished wires 25
- 6.5 Electronic wires — Multiple-conductor thermoplastic types 30
  - 6.5.1 General 30
  - 6.5.2 Physical properties of insulation 30

6.5.3	Physical properties of overall insulating coverings	30
6.5.4	Properties of finished wire	30
6.6	Electronic wires — Single-conductor thermoset types	32
6.6.1	General	32
6.6.2	Physical properties of insulation	32
6.6.3	Physical properties of jackets	33
6.6.4	Physical properties of overall insulating covering	33
6.6.5	Properties of finished wire	33
6.7	Electronic wires — Multiple-conductor thermoset types	36
6.7.1	General	36
6.7.2	Physical properties of insulation	36
6.7.3	Physical properties of overall insulating coverings	36
6.7.4	Properties of finished wire	36

## 7 Marking 38

7.1	Product	38
7.2	Package	39

## Tables

1	— Construction	40
2	— Multiple-conductor constructions	51
3	— Physical properties of insulations	52
4	— Diameters of solid conductors and areas of cross-sections of stranded conductors	56
5	— Maximum dc resistance of conductor at 25 °C, $\Omega/\text{km}$	57
6	— Insulation — Classes	58
7	— Jackets and coverings — Classes	60
8	— Matrix of test requirements for equipment wires — Thermoset	61
9	— Matrix of test requirements for equipment wires — Thermoplastic	62
10	— Cold bend test temperatures	63
11	— Mandrel diameter for cold bend test	63
12	— Test temperature and exposure time for heat-resistant properties	64
13	— Mandrel diameter for heat-resistant properties test	64
14	— Dielectric strength after temperature conditioning test voltages	65
15	— Deformation test temperature, load and duration	65
16	— Spark test voltages	66
17	— Dielectric strength test voltages	67
18	— Minimum insulation resistance at 15 °C ( $G\Omega\cdot\text{m}$ )	68
19	— Conditioning temperature and test voltage for dielectric strength test at elevated temperature	69
20	— Mandrel diameters for insulating varnish test	69
21	— Matrix of test requirements for lead wires (CL types)	70
22	— Heat-resistant properties — Types CL901 and CL905 wires	72
23	— Heat-resistant properties test on lead wires	73
24	— Number of turns around mandrel for heat-resistant properties and cold bend tests	74
25	— Dielectric strength test voltages	74
26	— Deformation test loading	74
27	— Mandrel diameters for cold bend test	75
28	— Insulating varnish test	75
29	— Conditioning temperature and test voltage for dielectric strength test at rated temperature	76
30	— Number of turns around the mandrel on the flexibility test	76
31	— Matrix of test requirements for GTO and ICS cables	76
32	— Physical properties of jackets/covering	77
33	— Dielectric strength test	79
34	— Mandrel diameter for extended voltage test	79
35	— Matrix of test requirements for single-conductor thermoplastic electronic wires	80

- 36** — Heat-resistant properties test conditions 81
  - 37** — Dielectric strength of Types TR, TRSR-64, and TTR following the heat-resistant properties and cold bend tests 81
  - 38** — Temperature for heat shock and shrinkage test — TV types 82
  - 39** — Deformation test 82
  - 40** — Mandrel diameter for dielectric strength test — TV types 83
  - 41** — Matrix of test requirements for multiple-conductor thermoplastic electronic wires 83
  - 42** — Mandrel diameter for bending test at low temperature 83
  - 43** — Matrix of test requirements for single-conductor thermoset electronic wires 84
  - 44** — Dielectric strength of RR types following the heat-resistant properties and cold bend tests 84
  - 45** — Deformation test 85
  - 46** — Matrix of test requirements for multiple-conductor thermoset electronic wires 85
- 

**Figures**

- 1** — Test method for high-voltage cut-through 86

# ***Technical Committee on Wiring Products***

<b>K.L. Rodel</b>	Hubbell Canada LP, Pickering, Ontario <i>Representing Manufacturers</i>	<i>Chair</i>
<b>S. Paulsen</b>	Province of New Brunswick, Fredericton, New Brunswick <i>Representing Regulatory Authorities</i>	<i>Vice-Chair</i>
<b>B. Haydon</b>	Canadian Standards Association, Mississauga, Ontario	<i>Project Manager</i>

## **Representing Regulatory Authorities**

<b>G. Montminy</b>	Régie du bâtiment du Québec, Québec, Québec
<b>T. Olechna</b>	Electrical Safety Authority, Mississauga, Ontario
<b>A. Tsisserev</b>	City of Vancouver, Vancouver, British Columbia

## **Representing Manufacturers**

<b>C. Davis</b>	Electro Cables Incorporated, Trenton, Ontario
<b>P. Desilets</b>	Leviton Manufacturing of Canada Limited, Pointe-Claire, Québec
<b>B.F. O'Connell</b>	Tyco Thermal Controls (Canada) Ltd., Trenton, Ontario
<b>D.S. Reith</b>	Nexans Canada Inc., Markham, Ontario

## **Representing General Interests**

<b>B. Beland</b>	Sherbrooke, Québec
<b>D.H. Dunsire</b>	Winnipeg, Manitoba
<b>C. Samuels</b>	ConocoPhillips Canada Ltd., Calgary, Alberta
<b>T. Simmons</b>	British Columbia Institute of Technology, Burnaby, British Columbia

# ***Integrated Committee on Flexible Cords/Equipment and Appliance Wires***

<b>B.L. Bukovec</b>	The Radix Wire Company, Cleveland, Ohio, USA	<i>Chair</i>
<b>W.F. Constantine</b>	Draka Cableteq USA, North Dighton, Massachusetts, USA	
<b>L. Coté</b>	Harbour Industries (Canada) Limited, Farnham, Québec	
<b>T.H. Cybula</b>	Underwriters Laboratories Inc., Melville, New York, USA	
<b>C. Davis</b>	Electro Cables Incorporated, Trenton, Ontario	
<b>P. Desilets</b>	Leviton Manufacturing of Canada Limited, Pointe-Claire, Québec	
<b>G.L. Dorna</b>	Belden Wire & Cable Company Engineering Center, Richmond, Indiana, USA	
<b>R. Duquet</b>	Harbour Industries (Canada) Limited, Farnham, Québec	
<b>T. Edwards</b>	Alcan Cable Division of Alcan Products Corp., Atlanta, Georgia, USA	
<b>S.B. Friedman</b>	General Cable Industries, Inc., Lincoln, Rhode Island, USA	
<b>B. Harmer</b>	CSA International, Toronto, Ontario	
<b>J. Hunter</b>	CABLE TECH Global, Mineral Wells, Texas, USA	
<b>T.R. Jurczak</b>	General Cable, Fort Wayne, Indiana, USA	
<b>W. Kowalski</b>	Coleman Cable Inc., Waukegan, Illinois, USA	
<b>G. Krishnan</b>	Southwire Canada Company, Stouffville, Ontario	

---

<b>R.E. Lageman</b>	First Capitol Wire & Cable Company, Inc., York, Pennsylvania, USA	
<b>R.H. Laney</b>	Draka Elevator Products, Inc., Rocky Mount, North Carolina, USA	
<b>D. Nester</b>	Igus Inc., East Providence, Rhode Island, USA	
<b>B. Parsons</b>	CABLE TECH Global, Mineral Wells, Texas, USA	
<b>J. Prema</b>	Shawflex, Toronto, Ontario	
<b>D.S. Reith</b>	Nexans Canada Inc., Markham, Ontario	
<b>T. Rudd</b>	Belden (Canada) Inc., Cobourg, Ontario	
<b>P. Schlichting</b>	Wirecraft Products Division Quirk Wire Company, Incorporated, West Brookfield, Massachusetts, USA	
<b>S. Stene</b>	Underwriters Laboratories Inc., Santa Clara, California, USA	
<b>D. Verhage</b>	Domtech Inc., Trenton, Ontario	
<b>E.D. Watanabe</b>	IUSA S.A. de C.V., Jocotitlan, Estado de Mexico	
<b>L. Letea</b>	Canadian Standards Association, Mississauga, Ontario	<i>Project Manager</i>

# Preface

This is the seventh edition of CSA C22.2 No. 127, *Equipment and lead wires*. It is one of a series of Standards issued by the Canadian Standards Association under *Part II* of the *Canadian Electrical Code*. It supersedes the previous editions, published in 1999, 1995, 1988, 1981, 1966, and 1964.

For general information on the Standards of the *Canadian Electrical Code, Part II*, see the preface to CAN/CSA-C22.2 No. 0, *General Requirements — Canadian Electrical Code, Part II*.

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 Flexible Cords/Equipment and Appliance Wires, 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](http://www.csa.ca).

# C22.2 No. 127-09

## ***Equipment and lead wires***

### **1 Scope**

#### **1.1**

This Standard applies to insulated conductors intended for internal wiring of electrical equipment, for leads of transformers, motors, etc., and for luminous-tube signs and ignition systems, to be installed in accordance with the *Canadian Electrical Code, Part I*.

#### **1.2**

Constructions to which this Standard applies are shown in [Tables 1](#) and [2](#). The Tables are not a complete summary of the construction details, but all of the items shown therein are requirements or limitations.

#### **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 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. 0.3-09

*Test methods for electrical wires and cables*

C22.2 No. 51-09

*Armoured cables*

C22.2 No. 75-08

*Thermoplastic-insulated wires and cables*

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

*Wire and cable test methods*