# UL 486A-486B

## STANDARD FOR SAFETY

Wire Connectors

UL Standard for Safety for Wire Connectors, UL 486A-486B

Third Edition, Dated April 27, 2018

***Summary of Topics***

***This revision of ANSI/UL 486A-486B dated May 5, 2021 includes the following changes in requirements:***

- ***Remove "Number of Strands" from Marking Requirement; 10.12***

- ***Add Specification that the Current-Cycling Test Shall be Performed with an 60 Hz ac Source; 7.2.1, Table 7, Table 8 and Table 13***

- ***Sizing and Lubricating Bushings During Secureness Test; 9.3.2.1 and Table 26***

- ***Correction to Table 13***

- ***Testing with Metric and Non-Standard Size Conductors; 1.2, 2.1.7, 3.2, 6.3.5, 7.1.6A, 7.1.7, 8.1.6, 8.1.9, 8.1.10, 8.1.11, 9.1.5.1, 9.1.5.1A, 9.1.5.1B, 9.1.5.3 – 9.1.5.5, 9.1.9.4, 10.7, 10.8, 10.10, 10.19, 10.34, 10.39, Table 7 – Table 9, Table 13, Table 14, Table 14A, Table 15 – Table 17, Table 19, Table 21, Table 26, Table 27, Annex A, Section C.4 and Annex F***

- ***Testing with Aluminum Wire with AA-8000 Alloy Conductors; 7.2.2, 7.2.3, 7.3.1, Table 15 and Annex A***

- ***Use of Shear Head Bolts; 9.1.9.4, 9.1.9.5 and 9.1.9.5A***

- ***Sample Length Change; B.1.2***

- ***Exothermically Welded Wire Connectors; 1.1 and 10.42***

Text that has been changed in any manner or impacted by UL'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 October 2, 2020 and January 22, 2021.

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Association of Standardization and Certification
NMX-J-543-ANCE
Fourth Edition

CSA Group
CAN/CSA-C22.2 No. 65-18
Sixth Edition

Underwriters Laboratories Inc.
UL 486A-486B
Third Edition

# Wire Connectors

April 27, 2018

(Title Page Reprinted: May 5, 2021)



Approved American National Standard

ANSI/UL 486A-486B-2021

National Standard of Canada
Standards Council of Canada
Norme nationale du Canada
Conseil canadien des normes

**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 Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and UL. CSA Group and UL 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 UL pages.



**ISBN 978-1-4883-1152-9 © 2018 Canadian Standards Association**



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This ANSI/UL Standard for Safety consists of the Third Edition including revisions through May 5, 2021. The most recent designation of ANSI/UL 486A-486B as an American National Standard (ANSI) occurred on May 5, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

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# PREFACE

This is the harmonized ANCE, CSA Group, and UL standard for Wire Connectors. It is the fourth edition of NMX-J-543-ANCE, the sixth edition of CSA-C22.2 No. 65, and the third edition of UL 486A-486B. This edition of NMX-J-543-ANCE supersedes the previous edition published on January 11, 2013. This edition of CSA-C22.2 No. 65 supersedes the previous edition published on January 11, 2013. This edition of UL 486A-486B supersedes the previous edition published on January 11, 2013.

This harmonized standard has been jointly revised on May 5, 2021. For this purpose, CSA Group and UL are issuing revision pages dated May 5, 2021, and ANCE is issuing a new edition dated May 5, 2021.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Connectors, of the Council on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

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 SC 20D – Conectadores part of the CT 20 – Conductores from the Comite de Normalizacion de la Asociacion de Normalizacion y Certificacion, A.C., CONANCE, with the collaboration of the connectors manufacturers and users.

This standard was reviewed by the CSA Subcommittee on Wiring Devices for Household and General Use, 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 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 uses the IEC format but is not based on, nor is it considered equivalent to, an IEC standard.

This standard is published as an equivalent standard for ANCE, CSA Group, and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

**Reasons for differences from IEC**

The Technical Harmonization Committee identified several IEC standards that address electrical wire connectors included in the scope of this standard. The IEC standards for electrical wire connectors are recognized as being generally system specific, containing the requirements for the relevant wire connectors and cables in many discrete IEC standards.

The THC determined the safe use of electrical wire connectors is dependent on the design and performance of the wire connectors in relation to the North American Electrical Codes with which they are intended to be installed. The THC agreed such future investigation will be facilitated by the harmonization of the North American Electrical Codes for wire connectors with IEC installation practices.

**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.

## 1 Scope

1.1 This Standard applies to single-polarity connectors for use with all alloys of copper or aluminum, or copper-clad aluminum conductors, or all three, for providing contacts between current-carrying parts, in accordance with the Canadian Electrical Code, Part I, C22.1, in Canada, the National Electrical Code, NFPA-70, in the United States of America, or the Standard for Electrical Installations, NOM-001-SEDE, in Mexico, as follows:

*Note: Copper-clad aluminum conductors are for use only in the United States in accordance with the National Electrical Code, NFPA 70.*

a) Pressure wire connectors intended to hold one or more conductor(s);

b) Connectors intended for use in appliances and equipment that comply with the requirements for such appliances and equipment;

c) Soldering connectors;

d) Splicing wire connectors intended for use with 4 AWG (21.2 $mm^2$) or larger conductors;

*Note: A splicing wire and cable connector taking a range of conductor sizes may include conductor sizes smaller than 4 AWG (21.2 $mm^2$).*

e) Neutral bars;

f) Uninsulated connectors that are used in circuits rated 35 000 V and below;

g) Ampere-rated connectors not intended for general use;

h) Insulation piercing connectors; and

i) Exothermically welded wire connectors.

1.1A Connectors covered by this Standard are also suitable for use with conductors that are prepared using ferrules evaluated in accordance with CSA C22.2 No. 291-14/UL 486F, or wire connector adapters evaluated in accordance with this Standard, under the following conditions:

a) Ferrules and adapters are applied in accordance with their ratings and installation instructions.

b) The length of exposed conductive material maintains the strip lengths required by the connector manufacturer.

1.2 This Standard is intended for connectors suitable for use with conductors in the size ranges as follows:

a) Aluminum:

1) 12 AWG (3.3 $mm^2$) and 10 AWG (5.3 $mm^2$) solid;

2) 12 AWG (3.3 $mm^2$) to 2 000 kcmil (1 010 $mm^2$) stranded, Class B concentric, compressed, and compact; and

3) 12 AWG (3.3 $mm^2$) to 1 000 kcmil (508 $mm^2$) stranded single input wire (SIW).

b) Copper-clad aluminum:

1) In Canada, this construction is not allowed.

2) In Mexico, this construction is not allowed.

3) In the United States:

i) 12 AWG (3.3 $mm^2$) and 10 AWG (5.3 $mm^2$) solid; and

ii) 12 AWG (3.3 $mm^2$) to 2 000 kcmil (1 010 $mm^2$) stranded, Class B concentric, compressed, and Class C concentric.

c) Copper:

1) 30 AWG (0.05 $mm^2$) to 10 AWG (5.3 $mm^2$) solid; and

2) 30 AWG (0.05 $mm^2$) to 2 000 kcmil (1 010 $mm^2$) stranded, Class B concentric and compressed, and Class C concentric.

d) Compact-stranded copper conductors:

1) In Canada for 8 AWG (8.4 $mm^2$) and larger;

2) In the United States for 2 AWG (33.6 $mm^2$) and larger; and

3) In Mexico for 8 AWG (8.4 $mm^2$) and larger.

e) Rigid (solid and stranded) metric wire sizes, Classes 1, 2, 5, and 6, in the range of 0.5 – 2 500 $mm^2$, in addition to AWG/kcmil sizes, with AWG/kcmil ratings mandatory and metric wire ratings optional.

*Note 1: Metric wire sizes are based on the IEC Standard for Conductors of Insulated Cables, IEC 60228.*
*Note 2: For example, a connector rated for 6 AWG – 350 kcmil may be additionally rated for 16 – 185 $mm^2$. See Annex C for example.*

f) Other class and strand configurations as indicated by marking.

1.3 This Standard is intended for connectors suitable for currents not exceeding the ampacity of insulated conductors rated 75°C or 90°C in accordance with the rating of the connector, if provided.

1.4 These requirements cover insulated connectors, insulating caps, and covers intended for use at 2 000 volts or less and uninsulated connectors for use in general use circuits rated 35 000 volts nominal or less.

In Canada, uninsulated connectors may also be used in applications up to 5 000 volts phase-to-phase where allowed and installed in accordance with Section 36 of the Canadian Electrical Code, Part I, C22.1. For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0.

1.5 This Standard does not apply to:

a) Insulated connectors for voltage levels above 2 000 V;

b) Manual twist-on connectors;

c) Built-in terminal connectors in devices rated less than 30 A intended for outlet box mounting or having provision for stress relief;

d) Flat quick connect terminals;

e) Wire binding screw terminals; and

f) Bare or covered ferrules intended for use with 1/0 – 20 AWG stranded copper conductors.

## 2 Reference Publications

### 2.1 Normative references

2.1.1 Where reference is made to any Standards, such reference shall be considered to refer to the latest editions and revisions thereto available at the time of printing, unless otherwise specified.

2.1.2 **ANCE Standards**

NMX-J-508-ANCE
*Electrical Features – Safety Requirements – Specifications and Test Methods*

2.1.3 **CSA Standards**

C22.1
*Canadian Electrical Code, Part I (CE Code)*

C22.0
*General-requirements – Canadian Electrical Code, Part II*

CAN/CSA-22.2 No. 0.17
*Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 291
*Bare and Covered Ferrules*

2.1.4 **UL Standards**

UL 94
*Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 486F
*Bare and Covered Ferrules*

UL 746C
*Polymeric Materials – Use in Electrical Equipment Evaluations*

2.1.5 **NFPA* Standard**

ANSI/NFPA 70,
*National Electrical Code (NEC)*

* National Fire Protection Association

2.1.6 **NOM Standards – Mexican Secretary of Energy**

NOM-001-SEDE,
*Standard for Electrical Installations*

2.1.7 **IEC† Standards**

IEC 60228
*Conductors of Insulated Cables*

† International Electrotechnical Commission.

**2.2 Informative references**

2.2.1 See Annex A for a listing of supplemental standards.

**3 Units of Measurement**

3.1 The values given in SI (metric) units shall be normative, except for AWG/kcmil conductor sizes. Any other values are for information purposes only.

3.2 For conductor sizes, AWG/kcmil conductor sizes are noted with their metric equivalents in parenthesis, followed by the closest metric conductor size covered by IEC 60228.

*Note 1: Specifications for conductor sizes for both AWG/kcmil and metric are shown as follows: 12 – 3 AWG (3.31 – 26.7) / 4.0 – 25.0 mm$^2$.*

*Note 2: IEC 60228 covers conductors in the metric range of 0.5 – 2 500 mm$^2$. For requirements covering AWG/kcmil wire ranges outside this scope, the specification for the metric conductor will be limited to the conductor range covered by IEC 60228.*

**4 Definitions**

For the purpose of this Standard, the following terms and definitions apply.

4.1 Circular mil (cmil) – the area of a circle with a diameter of 0.001 inch.

4.2 Connector – device for connecting a conductor to an equipment terminal or for connecting two or more conductors to each other.

4.3 Control Conductor – an unbroken conductor which is included in the current-cycling test loop.

4.4 Crimping Die – that part of a crimping tool which forms the crimp(s) and usually incorporates the crimp anvil(s), the crimp indentor(s), and the positioner.

*Note: Crimping dies may have separate or integral sections for compressing the insulation grip, if provided.*

4.5 Equalizer – a busbar that provides a point of equipotential and uniform current flow in a stranded conductor without adversely affecting the temperature of the connector(s).

4.6 Packaging Container – the container in which the unit containers are packaged.

4.7 Rated Current (Ampere Rating) – current assigned to the connector by the manufacturer.

4.8 Splicing Wire Connector – a connector that establishes a connection between two or more conductors by means of mechanical pressure and is not intended to be permanently mounted.

4.9 Single Input Wire (SIW) – a stranded conductor that varies the number of wires within a range of conductor sizes in order to permit that range of conductor sizes to be constructed from a single wire size.

4.10 Stability Factor S – the measure of temperature stability of a connector during the current-cycling test.

4.11 Temperature Rating – the maximum temperature of an insulated connector, assigned by the manufacturer.

4.12 Temperature Rise – the difference of the temperature of the connector, measured under load, and the ambient temperature.

4.13 Terminal Connector – a connector that establishes a connection between one or more conductors to a terminal plate or stud, or to any similar device, by means of mechanical pressure.

4.14 Unit Container – the smallest container in which connectors are packaged.

4.15 Voltage Rating – the maximum voltage of an insulated connector.

## 5 Symbols and Abbreviations

5.1 ° – Degree

5.2 A – Amps, Amperes

5.3 Al – Aluminum

5.4 AWG – American Wire Gage/gauge

5.5 C – Celsius

5.6 CC or CCA – Copper-clad aluminum

5.7 Cu – Copper

5.8 d – Days

5.9 f – Flexible

5.10 h – Hours

5.11 $HgNO_3$ – Mercurous nitrate

5.12 Hz – Hertz, cycles per second

5.13 in – Inch, Inches

5.14 kcmil – Thousand circular mil

5.15 m – Meter

5.16 mil – Thousandth of an inch

5.17 min – Minutes

5.18 ml – Milliliter

5.19 mm – Millimeter

5.20 $mm^2$ – Square millimeter

5.21 N – Newton – kilogram meter/$sec^2$

5.22 $NH_4$ – Ammonia

5.23 r – Rigid solid and rigid stranded

5.24 rpm – Revolutions per minute

5.25 s – Seconds

5.26 SAE – Society of Automotive Engineers

5.27 sol – Solid

5.28 str – Stranded

5.29 V – Volts

## 6 Construction Requirements

### 6.1 General

6.1.1 The design and construction of a connector intended for use with stranded conductors shall be such that all strands of the conductor shall be contained within the connector.

6.1.2 A connector intended for use with conductors of different sizes shall have a clamping mechanism that adapts to conductors of different sizes without permanent removal or addition of parts. Some examples of clamping mechanisms are:

a) Direct bearing screws with or without use of a pressure plate;

b) A pressure plate or plates and a screw or screws;

c) Deformation of the connector barrel (crimping) using a special tool;

d) A nut threading onto a split bolt; and

e) An element for insulation-piercing or displacement.

6.1.3 Any rearrangement or adjustment of a connector that is necessary to adapt it to various sizes of conductors shall be obvious unless the connector is marked as described in 10.11.

6.1.4 There shall be no sharp edges or corners on the outer surface of a connector that result in damage to insulation that the connector contacts.

6.1.5 The construction of a connector intended to secure more than a single conductor shall be such that there will be no intermixing (direct conductor contact) between the conductors of different materials unless

the connector is investigated and found to meet the performance requirements of this Standard and is marked in accordance with 10.24.

## 6.2 Materials

6.2.1 The main current-carrying part of a connector shall be of aluminum, an aluminum alloy, copper, a copper alloy, or other material investigated and found to meet the performance requirements of this Standard.

6.2.2 A connector intended for use with aluminum conductor(s) or a connector body of aluminum or aluminum alloy shall be coated with an electrically conductive coating, such as tin, that will inhibit oxidation and corrosion. The following need not be coated:

a) A splicing connector shipped prefilled with an oxide-inhibiting compound;

b) The conductor-securing (barrel) portion of a terminal connector that is shipped prefilled with an oxide-inhibiting compound;

c) An aluminum-bodied splicing connector that is intended for an aluminum conductor only;

d) The cut ends of a neutral bar;

e) The top cap of a lay-in connector not in contact with the wire; and

f) The mounting hole in a connector that is intended to be secured by a bolt, nut, and washer.

*Note: Other coatings may be used if investigated for the purpose and found suitable.*

6.2.3 Iron or steel, if protected against corrosion, may be used for screws, plates, yokes, or other parts that are employed as a means of clamping the conductor, if such parts are not the primary current-carrying members.

6.2.4 Insulation employed as a part of the connector shall be suitable for its rated temperature in accordance with Table 1.

6.2.5 The insulating material shall have a minimum flammability classification of V-2 or VTM-2 as determined by tests described in Annex B. The material thickness for determining the flammability shall be measured at points supporting live parts or within 6 mm (0.236 in) of live parts, whichever is less.

*Note: Insulating tubing that has a VW1 rating is not considered equivalent. Tubing may be tested using bar samples to achieve a V-2 minimum rating, or the glow wire test (see 6.2.6) may be performed.*

6.2.6 With reference to 6.2.5, a material other than V-2 or VTM-2 may be used when the insulation of the wire connector complies with the requirements for the glow-wire test as specified in UL 746C, or CSA C22.2 No. 0.17, or NMX-J-508-ANCE, with a glow wire at a temperature of 750°C.

## 6.3 Soldering lugs

6.3.1 A soldering lug shall be made of copper, brass, bronze, or other material that has been shown by investigation to meet the requirements of this Standard.

6.3.2 A lug of other than wrought copper shall be subjected to an investigation that evaluates if the lug has performance equivalent to that of a wrought-copper lug.

6.3.3 The diameter and depth of the conductor hole, the wall thickness, and the contact area of the tang of a wrought-copper lug shall not be less than the values specified in Table 2, according to the maximum size of conductor that the lug is intended to accommodate.

6.3.4 The diameters and areas of screws or bolts have not been standardized, and no addition or subtraction for these has been made in determining the areas specified in Table 2.

6.3.5 Soldering lugs shall not be rated for use with metric conductors.

## 7 Test Requirements

### 7.1 General

7.1.1 A connector shall meet the test requirements when separate specimen sets are subjected to the applicable tests for the design of the connector as specified in Table 3 through Table 5 and in 7.10 through 7.13.

7.1.2 With reference to 7.1.1, a connector of copper or copper alloy need not be subjected to the current-cycling sequence using copper conductor, unless the connector is dependent upon insulation piercing, insulation displacement, or spring action.

7.1.3 With reference to 7.1.1, the initial static-heating test need not be conducted in the static-heating sequence using copper conductor.

7.1.4 With reference to 7.1.1, for other than a tool-applied crimp connector, the current-cycling test using a copper conductor need not be performed when the connector has been current-cycling tested with an aluminum conductor of a size not smaller than the size of the copper conductor required for the current-cycling test.

*Note: See Annex C for example.*

7.1.5 Conductor sizes 30 – 20 AWG (0.05 – 0.52 $mm^2$) need not be subjected to the secureness test in the static-heating sequence or mechanical sequence.

7.1.6 Specimen sets shall be subjected to the test sequences using the conductor material specified in Table 6 for the one or more conductor material combinations for which the connector is intended. The dielectric withstand, stress corrosion, secureness of insulation, flexing, and low temperature installation tests may be conducted using either copper or aluminum or copper-clad aluminum conductor. When a connector is rated for copper-to-copper, aluminum-to-aluminum, and copper-to-aluminum (intermixed), or copper-clad aluminum, the mechanical sequence with copper-to-aluminum or copper-clad aluminum conductors may be omitted.

7.1.6A Testing may be conducted using AWG/kcmil solid and stranded sized conductors or Class 1 (rigid solid) and Class 2 (rigid stranded) metric sized conductors as follows:

a) AWG/kcmil solid conductors is representative of Class 1 metric conductors.

b) Class 1 metric conductors is representative of AWG/kcmil solid conductors.

c) AWG/kcmil stranded conductors is representative of Class 2 metric conductors.

d) Class 2 metric conductors is representative of AWG/kcmil stranded conductors.