UL 486F

STANDARD FOR SAFETY

Bare and Covered Ferrules

UL Standard for Safety for Bare and Covered Ferrules, UL 486F

Third Edition, Dated December 9, 2024

Summary of Topics

This new Third Edition ANSI/UL 486F dated December 9, 2024 extends the Scope to include large ferrules.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated January 5, 2024 and May 24, 2024.

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CSA Group
CSA C22.2 No. 291:24
Third Edition

ULSE Inc.
UL 486F
Third Edition

Bare and Covered Ferrules

December 9, 2024

Approved American National Standard

ANSI/UL 486F-2024

Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as “CSA Group”) and ULSE Inc. (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or ULSE at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and ULSE. CSA Group and ULSE will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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This ANSI/UL Standard for Safety consists of the Third Edition.

The most recent designation of ANSI/UL 486F as an American National Standard (ANSI) occurred on December 9, 2024. 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 CSA Group and ULSE standard for Bare and Covered Ferrules. It is the third edition of CSA C22.2 No. 291 and the third edition of UL 486F. This edition of CSA C22.2 No. 291 supersedes the previous editions published in 2019 and 2014.

This harmonized standard was prepared by CSA Group and ULSE. The efforts and support of the Technical Harmonization Subcommittee, CANENA Technical Harmonization Committee 99 – Electrical 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.

This standard was reviewed by the CSA Integrated Committee on Electrical Connectors, 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 CSA Group and ULSE.

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

At present there is no IEC standard for bare and covered ferrules. Therefore, this standard does not employ any IEC standard for base requirements.

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.

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1 Scope

1.1 These requirements cover bare and covered ferrules intended for field wiring and factory wiring for use in accordance with the National Electrical Code, NFPA 70 and Canadian Electrical Code, Part I, CSA C22.1.

1.2 This standard applies to ferrules that are intended to facilitate the connection of stranded wire on to devices, such as terminal blocks. Their purpose is to treat stripped wire and prevent turned back strands during installation. They are intended to be used to attach to one stranded copper conductor or two stranded copper conductors of the same size.

1.3 When intended for use with one conductor, these ferrules are suitable for use with 777 kcmil – 26 AWG, 380 – 0.14 mm^2, stranded copper conductors. For conductor sizes 8 AWG, 10 mm^2 or larger, these ferrules are suitable for use with stranded copper conductors that are more finely stranded than Class B or C conductors.

NOTE: Examples of stranding classes more finely stranded than class B or C are classes G, H, I, K, M, 5, and 6. In addition, Type DLO cable is more finely stranded than Class B or C.

1.4 When intended for use with two conductors, these ferrules are suitable for use with (2) 6 – (2) 26 AWG, (2) 16 – (2) 0.25 mm^2, stranded copper conductors.

1.5 This standard applies to ferrules that are intended to be terminated in wire connection devices rated for:

a) Solid copper conductors; and/or

b) Stranded copper Class B and C conductors – applicable to wire connection devices rated to terminate conductor sizes 8 AWG, 10 mm^2 or larger.

1.6 Ferrules covered by this standard are not intended for use in IDC (insulation displacement connection) terminal blocks.

1.7 This Standard applies to Ferrules rated for use with conductor sizes 2/0 AWG, 70 mm^2 or larger that are intended for use in aluminum and copper body mechanical connectors with dome and conical shaped screws that apply direct pressure to the conductor being terminated.

1.8 This standard does not apply to wire connectors such as pin adapters covered in CSA C22.2 No. 65 or UL 486A-486B.

1.9 Ferrules covered by this standard may be used with equipment having short circuit ratings of:

a) 85,000 A maximum, or

b) 100,000 A maximum if supplied by an overcurrent protective device, and the equipment short-circuit current rating, divided by the number of conductors per phase, results in a current of 50,000 A or less per conductor.

2 Normative References

2.1 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.

C22.1, *Canadian Electrical Code, Part I*

CSA C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 65, *Wire Connectors*

IEC 60228, *Conductors of Insulated Cables*

NFPA 70, *National Electrical Code (NEC)*

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

UL 486A-486B, *Wire Connectors*

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

UL 1694, *Tests for Flammability of Small Polymeric Component Materials*

3 Units of Measurement

3.1 The values given in SI (metric) units shall be normative, except for AWG conductor sizes. Any other values given are for information only. AWG/kcmil and metric conductor sizes shall both be normative sizes for this standard. Metric conductor sizes are not exact conversions of the AWG/kcmil sizes.

4 Definitions

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

4.2 COVERED – Encased within material of composition or thickness that is not recognized as electrical insulation.

4.3 COVERED FERRULE – A ferrule provided with a plastic sleeve.

4.4 FERRULE – A conductive sleeve used to facilitate the termination of stranded wire in devices used to terminate solid conductors.

4.5 PLASTIC SLEEVE – A non-conductive plastic material used for covering purposes. The term "covering" is also referred to in the Standard as a "plastic sleeve".

5 General Requirements

5.1 For products intended for use in Canada, general requirements are given in CSA C22.2 No. 0, General Requirements – Canadian Electrical Code, Part II.

6 Symbols and Abbreviations

6.1 ° – Degree

6.2 AWG – American Wire Gage/gauge

6.3 C – Celsius

6.4 mm^2 – Squared millimeters

6.5 V – Volts

6.6 A – Amps

7 Construction

7.1 General

7.1.1 A ferrule shall be provided with one opening to accept one or two stranded type copper conductors applied with compression tooling.

7.1.2 A ferrule shall comply with the dimensional requirements in Table 7.1 – Table 7.6 and Figure 7.1 – Figure 7.10 and the following:

a) Dimensions for the length of the ferrules in all Tables and Figures represent common sizes and longer lengths are permissible as these dimensions are indicated as minimum values. For Table 7.3 and Table 7.5, which specify “strip length”, any increase in overall length of the ferrule shall include an equal amount of increase in the strip length specified by the manufacturer.

b) Dimensions for the diameter and thickness for plastic sleeves in ***Table 6*** and Table 7.6 and Figure 7.8 and Figure 7.10 represent common sizes. Wider dimensions and thicker materials for the plastic sleeves are permissible, as these dimensions are indicated as minimum values.

Table 7.1
Ferrules, Form A and E

Conductor cross-section		d_1		d_2	l	s		Color identification code for plastic sleeve (Informative only)
AWG	(mm^2)	mm	Tolerance	Min.	Min.	mm	Tolerance	
26	(0.14)	0.6	±0.14	1.4	4.3	0.15	±0.05	grey
24	(0.25)	0.8		1.5	4.3			yellow
22	(0.34)	0.9		1.6	4.3			turquoise
20	(0.5)	1.0		1.9	5.3			white
18	(0.75)	1.2		2.1	5.3			grey
–	(1)	1.4		2.3	5.3			red
16	(1.5)	1.7	±0.25	2.6	6.0			black
14	(2.5)	2.2		3.2	6.0			blue
12	(4)	2.8		3.8	9.0	0.2		grey
10	(6)	3.5	±0.30	4.5	9.0			yellow
8	(10)	4.5		5.6	10.8			red
6	(16)	5.8		7.3	10.5			blue
4	(25)	7.3	±0.40	9.0	13.0			yellow
2	(35)	8.3		10.5	16.0			red
1-1/0	(20)	10.3		12.5	15.0	0.3		blue
2/0	–	12.1	±2.0	13.6	16	0.4	±0.1	yellow
–	(70)	13.5		15.0	16	0.4		yellow
3/0	–	14.2		15.7	22	0.4		red
–	(95)	14.7		16.2	22	0.4		red
4/0	–	16.0		16.5	22	0.5		blue
–	(120)	16.6		18.1	22	0.5		blue
250	–	17.3		18.5	22	0.5		blue
262	–	17.3		18.8	22	0.5		blue
–	(150)	18.6		20.1	25	0.5		yellow
300	–	19.1		20.6	25	0.5		yellow
313	–	19.1		20.6	25	0.5		yellow

Table 7.1 Continued on Next Page

Table 7.1 Continued

Conductor cross-section		d_1		d_2	l	s		Color identification code for plastic sleeve (Informative only)
AWG	(mm^2)	mm	Tolerance	Min.	Min.	mm	Tolerance	
350	–	20.5		22.0	25	0.6		–
–	(185)	20.8		22.3	25	0.6		–
373	–	20.5		22.0	25	0.6		–
400	–	22.5		23.0	28	0.6		–
444	–	22.5		24.0	28	0.6		–
–	(240)	23.0		24.5	28	0.6		–
500	–	23.7		24.8	28	0.6		–
535	–	23.7		25.2	28	0.6		–
–	(300)	26.2		27.7	32	0.7		–
600	–	26.2		27.7	32	0.7		–
646/650	–	26.2		27.7	32	0.7		–
700	–	27.4		28.9	33	0.7		–
750	–	29		30.5	34	0.7		–
777	–	29		30.5	34	0.7		–

NOTE: All dimensions in mm unless otherwise stated.

Table 7.2
Crimp-Type Ferrules With and Without Wire Insulation Grip, Forms B and C (Figure 7.2 and Figure 7.3)

Nominal size		Conductor cross section		a_1	a_2	b_1	b_2	h_1	h_2	l_1	s
Conductor cross section, mm^2	Length l_1 -0.4 mm	AWG	(mm^2)	-0.5	±0.5	±0.5	±0.5	±0.5	±0.5	-0.5	±0.05
1	7 10	20 – 18	(0.5 – 1)	11 14	2.5	2.5	3.7	2.6	3.8	7 10	0.3
1.5	7 10	18 – 16	(1 and 1.5)	11 14		3		3.3	4.2	7 10	
2.5	7 10	16 – 14	(1.5 and 2.5)	11 14		3.8	5	4.1	5.2	7 10	
4	8.5 12	14 – 12	(2.5 and 4)	14 17.5	3.5	4	5.6	4.8	6.3	8.5 12	0.4
6	8.5 12 15	12 – 10	(4 and 6)	14 17.5 20.5	3.5	4.8	6.4	5.4	7.8	8.5 12 15	

NOTE: All units are in mm unless otherwise stated.

Table 7.3
Assembled Crimp-Type Ferrules With and Without Wire Insulation Grip, Forms B and C (Figure 7.2 and Figure 7.3)

Nominal size		Conductor Cross section		Conductor strip length l_2	b_3	d	h_3
Cross section of conductor mm²	Length l_1 -0.4 mm	AWG	(mm²)	max		max	max
1	7 10	20 – 18	(0.5 – 1)	8 11	2	2.7	1.2
1.5	7 10	18 – 16	(1 and 1.5)	8 11	2.4	3.1	1.5
2.5	7 10	16 – 14	(1.5 and 2.5)	8 11	2.8	3.6	2.4
4	8.5 12	14 – 12	(2.5 and 4)	10 13.5	3.6	4.2	3.1
6	8.5 12 15	12 – 10	(4 and 6)	10 13.5 15.5	4.3	5.2	4
NOTE: All units are in millimeters unless otherwise stated.							

Table 7.4
Conductor-Embracing Ferrules Without Wire Insulation Grip, Form D

Nominal size		Conductor cross-section		b	h	l_1
Conductor cross section	Length l_1 -0.4 mm	AWG	(mm²)	±0.5	±0.5	
1	7 10	20 – 18	(0.5 – 1)	2.5	2.6	7 10
1.5	7 10	16	(1.5)	2.5	2.8	7 10
2.5	7 10	14	(2.5)	3	3.2	7 10
NOTE: All units are in millimeters unless otherwise stated.						

Table 7.5
Conductor-Embracing Ferrules Without Wire Insulation Grip, Form D

Nominal size		Conductor Cross section		d	Strip length l_2
Conductor cross section mm²	Length l_1 -0.4 mm	AWG	(mm²)	max	
1	7 10	20 – 18	(0.5 – 1)	1.8	8 11
1.5	7 10	16	(1.5)	2	8 11
2.5	7 10	14	(2.5)	2.5	8 11
NOTE: All units are in millimeters unless otherwise stated.					

Table 7.6
Two Conductor (Twin) Ferrules, Form F

Nominal size		Conductor cross-section		d_1		d_2		d_3		l_1		l_2		s_1		s_2		Color identification code for plastic sleeve (Informative only)
Conductor cross section	Length l_2	AWG	(mm^2)		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance		Tolerance	
2 × 0.25	8	2 × 24	(2 × 0.25)	1.15	±0.14	1.8	-0.2	3.4	-0.2	15	-1.5	8	-0.4	0.15	±0.05	0.25	-0.1	Any
2 × 0.34	8	2 × 22	(2 × 0.34)	1.15		1.8		3.4		15		8		0.15		0.25		Any
2 × 0.50	8	2 × 20	(2 × 0.50)	1.40		2.5		4.7	-0.3	15		8		0.15		0.25		White
2 × 0.75	8 10	2 × 18	(2 × 0.75)	1.7		2.8		5	-0.4	15 17		8 10		0.15		0.25		Grey
2 × 1	8 10 12 18	2 × 18	(2 × 1)	1.95	±0.25	3.4		5.4		15 17 19 25	-0.2	8 10 12 18	-0.6	0.15		0.3		Red
2 × 1.5	8 12 18	2 × 16	(2 × 1.5)	2.2		3.6		6.6		16 20 26	-1.5 -0.2	8 12 18	-0.4 -0.6	0.15		0.3		Black
2 × 2.5	10 13	2 × 14	(2 × 2.5)	2.8		4.2		7.8		18.5 21.5	-1.5	10 13	-0.4 -0.6	0.2		0.3		Blue
2 × 4	12	2 × 12	(2 × 4)	3.7	±0.3	4.9	-0.4	8.8		23	-0.2	12	-0.6	0.2		0.4	-0.15	Grey
2 × 6	14	2 × 10	(2 × 6)	4.8		6.9		10	-0.5	26		14		0.2		0.4		Yellow
2 × 10	14	2 × 8	(2 × 10)	6.4	±0.4	7.2		13		26		14		0.2		0.4		Red
2 × 16	14	2 × 6	(2 × 16)	8.2		9.6		18.4	-1	30		12		0.2		0.4		Blue

NOTE: All dimensions in mm unless otherwise stated.

Figure 7.1

Tubular Ferrules Without Plastic Sleeve, Form A

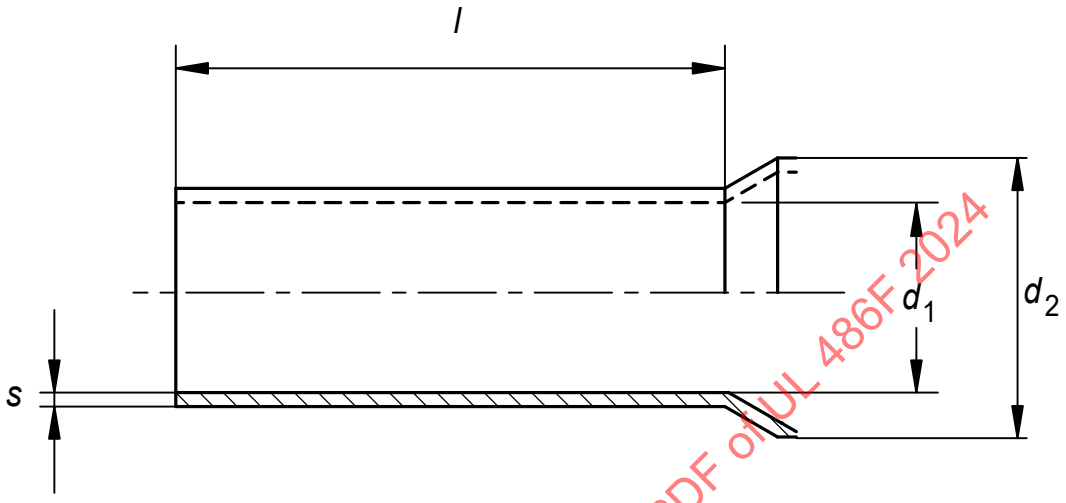

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Figure 7.2

Crimp-Type Ferrule With Wire Insulation Grip, Form B

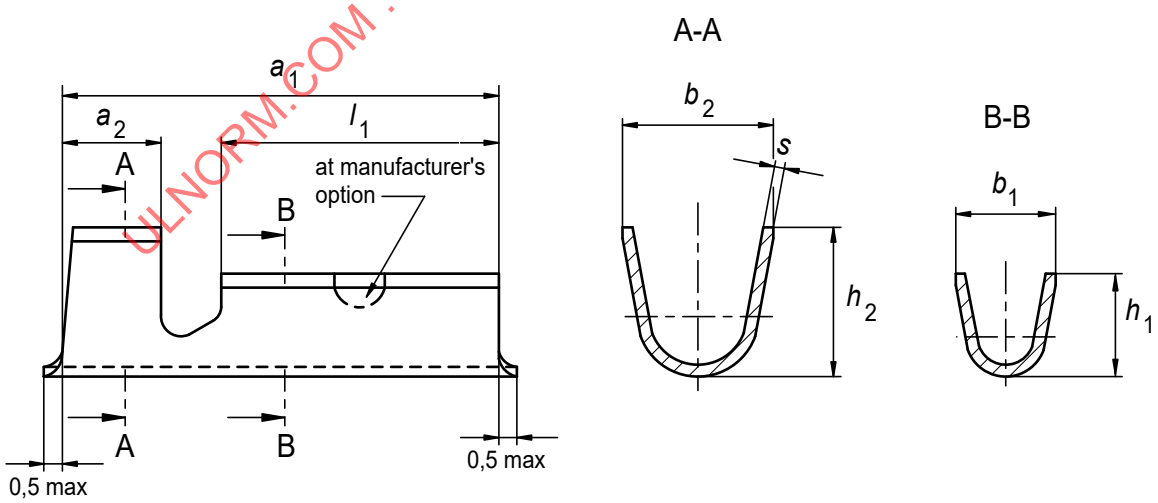

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Figure 7.3

Crimp-Type Ferrule Without Wire Insulation Grip, Form C

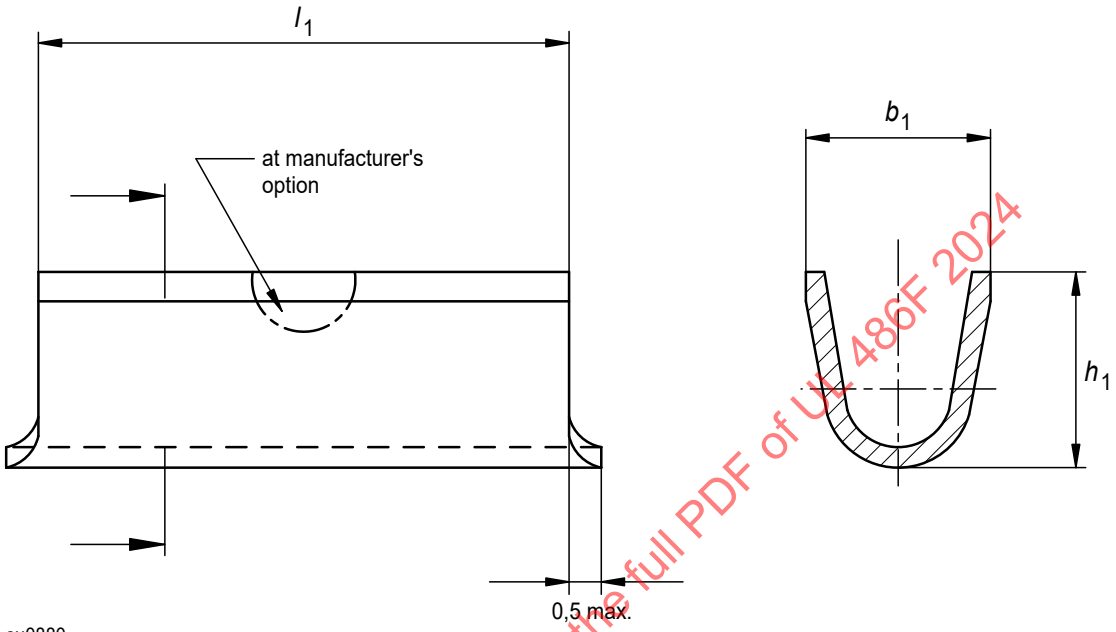

Figure 7.4

Crimp Dimensions for Form B

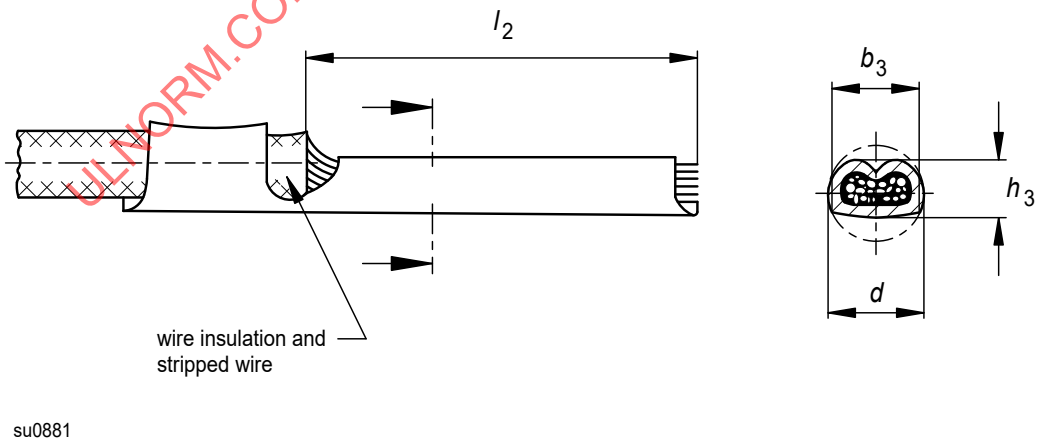

Figure 7.5

Crimp Dimensions for Form C

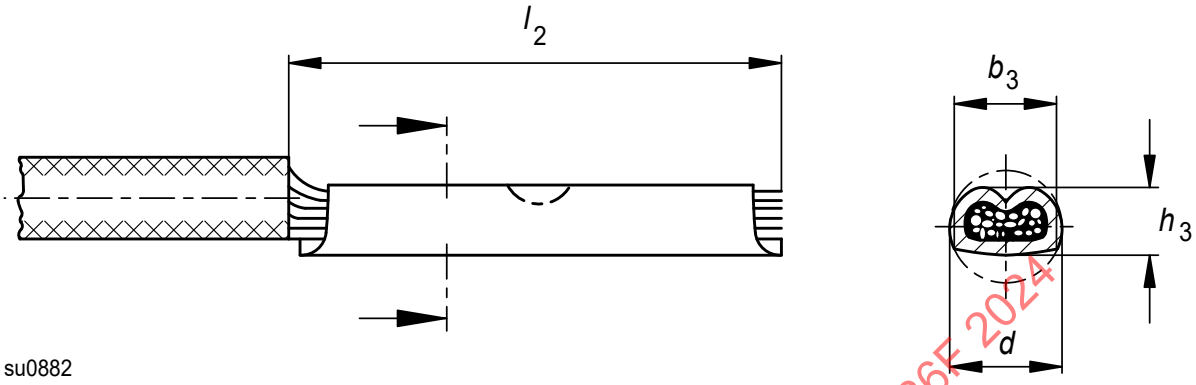

Figure 7.6

Form D

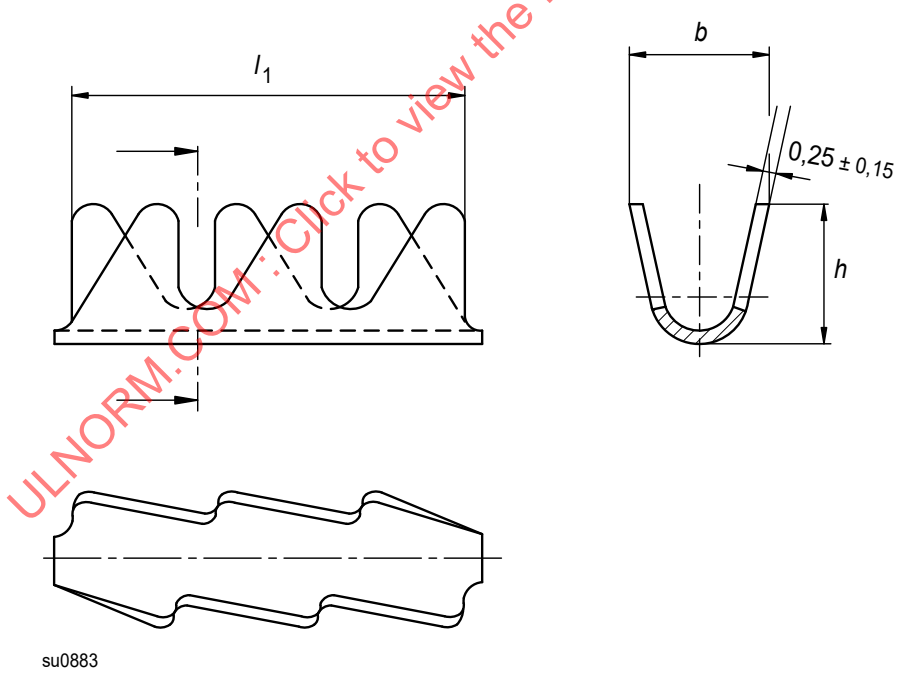

Figure 7.7

Form D

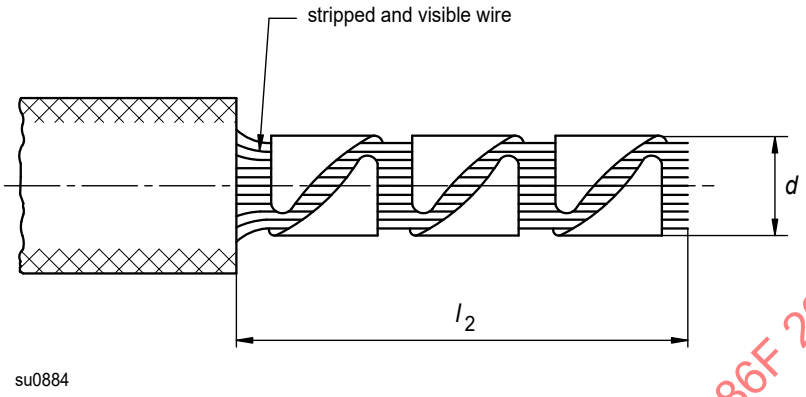

Figure 7.8

Ferrule With Plastic Sleeve, Form E

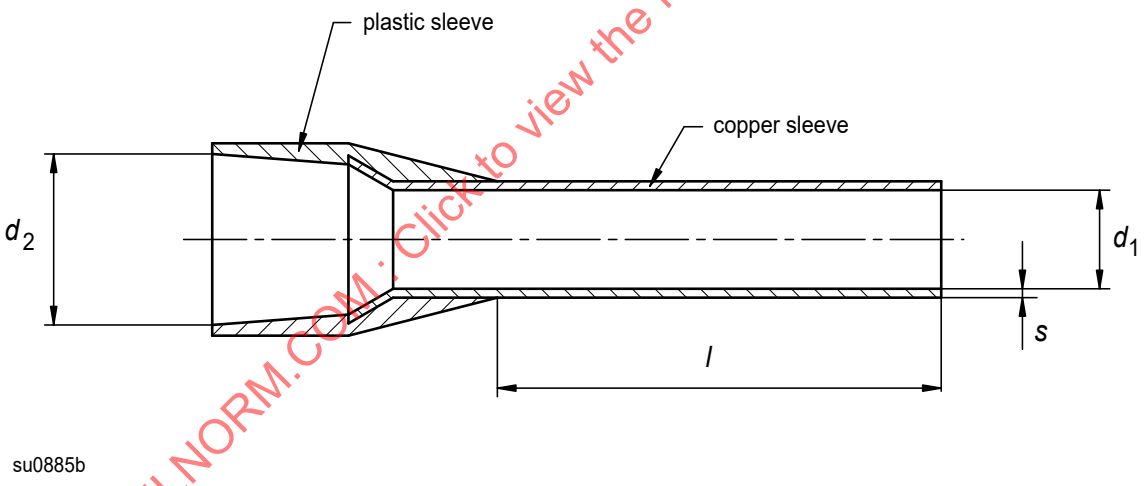

Figure 7.9

Form E

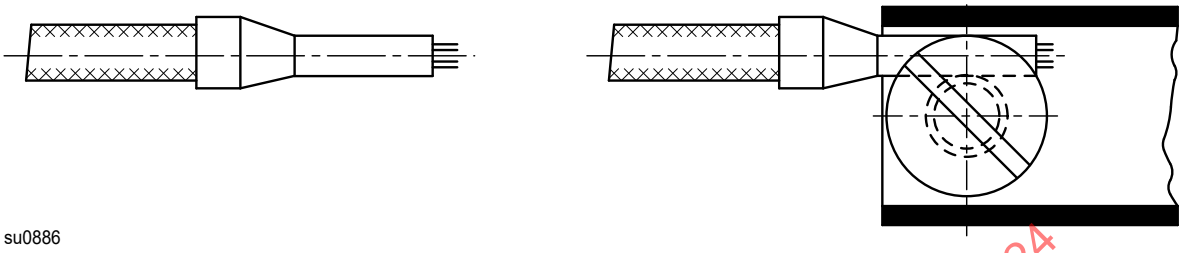

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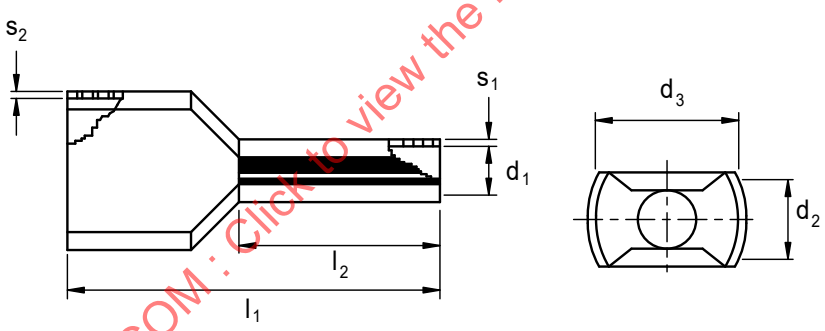
Figure 7.10

Two Conductor (Twin) Ferrules, Form F



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7.2 Materials

7.2.1 A ferrule shall be of copper or a copper alloy containing at least 80 % copper and be coated with tin.

7.3 Flammability

7.3.1 The covering material shall comply with one of the following requirements for flammability:

a) Have a minimum flammability classification of HB as determined by tests described in UL 94 or CSA C22.2 No. 0.17. This flammability classification may be determined at the minimum thickness employed in the construction or a nominal thickness of 0.8 mm (0.031 in), whichever is greater;

b) Meet the glow wire test as specified in UL 746C or CSA C22.2 No 0.17 for a temperature of 650 °C; or

c) Be evaluated and classed with a flammability rating of SC-0, SC-1, SC-TC 0, or SC-TC 1 in accordance with UL 1694.

7.4 Thermal properties

7.4.1 A polymeric material used for covering shall have a minimum relative thermal index (RTI) of 80 °C (176 °F) (electrical only). The material shall be evaluated using the specimen thickness employed in the covering or a nominal thickness of 0.8 mm (0.031 in), whichever is greater. The electrical RTI value may be determined regardless of the color used for the plastic sleeve.

8 Test Requirements

8.1 General

8.1.1 All ferrules shall comply with the test requirements in 8.2. Covered ferrules shall additionally comply with the test requirements in 8.3 – 8.4.

8.2 Tensile test

8.2.1 During testing in accordance with 10.2, the conductor shall not visibly move (with normal or corrected to normal vision) within the ferrule or be pulled out of the ferrule.

8.3 Mold stress relief

8.3.1 As a result of conditioning as specified in 10.3, there shall not be any warpage, shrinkage, or other distortion that results in interference with the operation, function, or installation of the device.

8.4 Dielectric voltage-withstand

8.4.1 The plastic sleeve of a covered ferrule shall withstand the applied potential without breakdown when tested in accordance with 10.4.

9 Sampling Requirements

9.1 General

9.1.1 The number of samples required for each test shall be as described in 9.2 – 9.4.

9.2 Tensile test

9.2.1 Three samples shall be tested for each of the assemblies in 10.1.1 and 10.1.2.

9.2.2 Testing on shorter ferrule lengths represent longer ferrules when all other dimensions are identical.

9.3 Mold stress test

9.3.1 Six samples shall be tested for each of the assemblies in 10.1.1 and 10.1.2.

9.4 Dielectric voltage-withstand

9.4.1 The same samples subjected to the mold stress test shall then be subjected to the dielectric voltage-withstand test.

10 Test Methods

10.1 General

10.1.1 A ferrule shall be assembled to the following conductors in the intended manner using the identified tooling and strip length [see 11.1.1 (e) and (f), and Annex A for Conductor Stranding]:

a) Largest size conductor with highest stranding count;

b) Largest size conductor with lowest stranding count;

c) Smallest size conductor with highest stranding count; and

d) Smallest size conductor with lowest stranding count.

10.1.2 A two conductor (twin) ferrule shall be assembled to the following conductors in the intended manner using the identified tooling and strip length [see 11.1.1 (e) and (f)]:

a) Largest size conductors with highest stranding count;

b) Largest size conductors with lowest stranding count;

c) Smallest size conductors with highest stranding count; and

d) Smallest size conductors with lowest stranding count.

10.2 Tensile test

10.2.1 The conductor shall be inserted through a punched hole in a plate which is securely fastened to a tensile machine. A minimum force in accordance with Table 10.1 shall be applied at a rate not to exceed 25.4 mm per min (1 in per min). The force shall be applied for 1 min.

Table 10.1
Tensile Force

Conductor cross section		Force[a]	
AWG	(mm^2)	N	(lbf)
26	(0.14)	7	(1.6)
24	(0.25)	10	(2.2)
22	(0.34)	15	(3.4)
20	(0.5)	20	(4.5)
18	(0.75)	30	(6.7)
–	(1)	35	(7.9)
16	(1.5)	40	(9)
14	(2.5)	50	(11.2)
12	(4)	60	(13.5)
10	(6)	80	(18)
8	(10)	90	(20.2)
6	(16)	100	(22.5)

Table 10.1 Continued on Next Page