UL 486E

STANDARD FOR SAFETY

Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

UL Standard for Safety for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E

Sixth Edition, Dated January 31, 2024

Summary of Topics

This new Sixth edition of ANSI/UL 486E dated January 31, 2024 includes the following changes in requirements:

– Addition to the Scope to address use of ferrules and adapters; 1.4

– Remove reference to a "Dielectric-Withstand Test"; 8.1.2 and 9.1.6.2

– Clarify that aluminum test conductors can be compact, compressed, or concentric stranding; 7.1.13

– Use of busbar during static heating test; 9.3.1.1

– Time stabilization clarification; 9.2.1 and 9.2.4

– Remove "number of strands" from marking requirement; 10.12

– Sizing and lubricating bushings during secureness test; 9.3.2.1 and Table 9.13

– Corrections to Table 8.3

– Testing with metric and non-standard size conductors; 1.3, 2.1.3, 3.2, 7.1.7, 7.1.10, 8.1.6, 8.1.7, 9.1.5.2, 9.1.5.3, 9.1.5.5, 9.1.5.6, 9.1.9.4, 10.4, 10.7, 10.8, 10.10, 10.26, 10.30, Table 7.5, Table 7.6, Table 8.3, Table 9.1, Table 9.2, Table 7.4, Table 9.3 – Table 9.6, Table 9.8, Table 9.13, Table 9.14, Section B4, and Annex E

– Testing with aluminum wire with AA-8000 alloy conductors; 7.2.2, 7.2.3, 7.3.1, Table 7.4, and Annex A

– Use of shear head bolts; 9.1.9.4, 9.1.9.5 and 9.1.9.6

– Insulating covers during stress corrosion tests; 9.6.1

– Addition of stranding table; 9.1.5.6 and Annex F

– Thermal testing with insulation colors other than black; 9.1.5.8, 9.1.5.9 and 9.1.5.10

– Alternate information means; 10.32

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 29, 2023 and December 15, 2023.

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Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

First Edition – August, 1984
Second Edition – May, 1988
Third Edition – December, 1994
Fourth Edition – May, 2009
Fifth Edition – September, 2015

Sixth Edition

January 31, 2024

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

The most recent designation of ANSI/UL 486E as an American National Standard (ANSI) occurred on January 31, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time.Proposals should be submitted via a Proposal Request in the On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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ANNEX F (Informative) – CONDUCTOR STRANDING

1 Scope

1.1 This Standard applies to equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, in accordance with the National Electrical Code, NFPA 70, as follows:

a) Equipment wiring terminals intended to hold one or more conductor(s);

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

c) Ampere-rated equipment wiring terminals;

d) Horsepower rated equipment wiring terminals; and

e) Wire range rated equipment wiring terminals.

1.2 These requirements apply to field wired equipment wiring terminals which are an integral part of the equipment, or are intended for use in specific equipment.

1.3 This Standard is intended for equipment wiring terminals 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; and

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

b) Copper-Clad Aluminum:

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

2) 12 AWG (3.3 mm^2) to 2 000 kcmil (1 010 mm^2) stranded, Class B 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 for 2 AWG (33.6 mm^2) and larger.

e) Rigid (solid and stranded) metric wire sizes, Classes 1, 2, 5, and 6, in the range of 0.5 – 1 000 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, an equipment wiring terminal rated for 6 AWG – 250 kcmil may be additionally rated for 16 – 120 mm^2. See Annex B for example.

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

1.4 Equipment wiring terminals covered by this Standard are also suitable for use with conductors that are prepared using ferrules evaluated in accordance with UL 486F, or wire connector adapters evaluated in accordance with UL 486A-486B, 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.

1.5 This Standard is intended for equipment wiring terminals suitable for currents not exceeding the ampacity of insulated conductors rated 75 °C or 90 °C in accordance with the rating of the equipment wiring terminal, if provided.

1.6 This Standard does not apply to:

a) Insulated equipment wiring terminals; and

b) Wire binding screw terminals.

2 Reference Publications

2.1 Normative references

2.1.1 For undated references to Standards, such reference shall be considered to refer to the latest edition and all revisions to that edition up to the time when this Standard was approved. For dated references to Standards, such reference shall be considered to refer to the dated edition and all revisions published to that edition up to the time the Standard was approved.

2.1.2 **NFPA* Standard**

NFPA 70-2011, *National Electrical Code (NEC)*

* National Fire Protection Association

2.1.3 **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 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. Metric wire sizes larger than 1 000 mm^2 are not covered by this standard.

4 Definitions

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

4.2 CIRCULAR MIL (cmil) – the area of a circle with a diameter of 0.001 inch.

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 equipment wiring terminal(s).

4.6 EQUIPMENT WIRING TERMINAL – establishes a connection between one or more conductors to a terminal plate or stud, or to any similar device, by means of mechanical pressure.

4.7 PACKAGING CONTAINER – the container in which the unit containers are packaged.

4.8 RATED CURRENT (AMPERE RATING) – current assigned to the equipment wiring terminal by the manufacturer.

4.9 STABILITY FACTOR S – the measure of temperature stability of a equipment wiring terminal during the current-cycling test.

4.10 TEMPERATURE RISE – denotes the difference of the temperature of the equipment wiring terminal, measured under load, and the ambient temperature.

4.11 UNIT CONTAINER – the smallest container in which equipment wiring terminals are packaged.

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 – 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 an equipment wiring terminal intended for use with stranded conductors shall be such that all strands of the conductor shall be contained within the equipment wiring terminal.

6.1.2 An equipment wiring terminal that is suitable for compact-stranded conductors shall also accept all strands of a Class B concentric-stranded conductor of the same size.

6.1.3 An equipment wiring terminal 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 equipment wiring terminal barrel (crimping) using a special tool;

d) A spring pressure terminal; and

e) An element for insulation-piercing or displacement.

6.1.4 Any rearrangement or adjustment of an equipment wiring terminal that is necessary to adapt it to various sizes of conductors shall be obvious unless the equipment wiring terminal is marked as described in 10.11.

6.1.5 There shall be no sharp edges or corners on the outer surface of an equipment wiring terminal that result in damage to insulation that the equipment wiring terminal contacts.

6.1.6 The construction of an equipment wiring terminal 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 equipment wiring terminal is investigated and found to meet the performance requirements of this Standard and is marked in accordance with 10.20.

6.1.7 If the method of mounting an equipment wiring terminal is such that the mounting means cannot be retightened after wires are installed, or after the equipment wiring terminal is mounted in equipment, the mounting means – by inherent features or manufacturer's specifications – shall limit rotation of the terminal around its mounting means to 30° or less.

6.2 Materials

6.2.1 The main current-carrying part of an equipment wiring terminal 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 The main current-carrying part of an equipment wiring terminal may be of plated steel or unplated steel of a corrosion-resistant alloy if the equipment wiring terminal complies with the requirements for the end product.

6.2.3 An equipment wiring terminal intended for use with aluminum conductor(s) or an equipment wiring terminal 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) The wire-securing (barrel) portion of an equipment wiring terminal that is shipped prefilled with an oxide-inhibiting compound;

b) The top cap of a lay-in equipment wiring terminal not in contact with the wire; and

c) The stamped mounting hole in an equipment wiring terminal 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.

6.2.4 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.

6.2.5 In regards to 6.2.4, an equipment wiring terminal intended for use in an appliance or equipment that complies with the requirements for such appliance or equipment may be plated steel or unplated steel of a corrosion-resistant alloy.

7 Test Requirements

7.1 General

7.1.1 An equipment wiring terminal shall meet the test requirements when separate sets of specimens are subjected to the applicable tests for the design of the equipment wiring terminal as specified in Table 7.1 – Table 7.2 and in 7.5 – 7.6.

Table 7.1
Test Sequences for All Connectors

Sequence			
1	**2[a]**	**3[b]**	**4[c]**
Current-cycling	Static-heating Secureness Static-heating (repeated) Pullout	Secureness Pullout	Stress Corrosion
Note – Table 1 applies to equipment wiring terminals for non-parallel applications, in which case Table 7.2 would not be applicable. However, some equipment wiring terminals may have dual functionality, both parallel and non-parallel, in which case both Tables are applicable.			
[a] This series of tests is referred to as static-heating sequence. [b] This series of tests is referred to as mechanical sequence. [c] The stress corrosion test, either moist ammonia or mercurous nitrate, need only be conducted for copper alloy parts not conforming to the copper requirements in 7.5 and 7.6.			

Table 7.2
Test Sequences for All Equipment Wiring Terminals Intended for Parallel Conductors

Sequence			
1	**2**	**3[a]**	**4[b]**
Current-cycling	Static-heating	Secureness Pullout	Stress Corrosion
Note – Table 2 applies to equipment wiring terminals for parallel applications, in which case Table 7.1 would not be applicable. However, some equipment wiring terminals may have dual functionality, both parallel and non-parallel, in which case both Tables are applicable.			
[a] This series of tests is referred to as mechanical sequence. [b] The stress corrosion test, either moist ammonia or mercurous nitrate, need only be conducted for copper alloy parts not conforming to the copper requirements in 7.5 and 7.6.			

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