

UL 486B

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Wire Connectors for Use with Aluminum Conductors

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety for Wire Connectors for Use With Aluminum Conductors, UL 486B

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Revisions: This Standard contains revisions through and including May 23, 2001.

UL is in the process of converting its Standards for Safety to the Standard Generalized Markup Language (SGML), and implementing an SGML compliant document management and publishing system. SGML - an international standard (ISO 8879-1986) - is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Significant benefits that will result from UL's use of SGML and these new systems include increased productivity, reduced turnaround times, and data and information consistency, reusability, shareability, and portability. However, the fonts, pagination, and general formatting of UL's new electronic publishing system differ from that of UL's previous publishing system. Consequently, when revision pages are issued for a Standard with the new publishing system, these differences may result in the printing of pages on which no requirements have been changed - these additional pages result from relocation of text due to repagination and reformatting of the Standard with the new publishing system.

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The new and revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated December 18, 2000. The bulletin(s) is now obsolete and may be discarded.

The revisions dated May 23, 2001 include a reprinted title page (page1) for this Standard.

Tables 7.4, 13.1, and 14.2 on pages dated May 22, 2000 have been marked changed as a result of UL's electronic publishing process. This change is editorial and for appearance only. No change has been made to the values in the tables.

The revisions dated June 25, 1997 was issued to correct a typographical error in Table 9.1 for the heat cycling test current for No. 4 AWG, 75°C rating.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if

the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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February 26, 1997

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 486B on June 22, 1992 . The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements apply to pressure wire connectors intended for use with aluminum or copper-clad aluminum conductor or both according to the National Electrical Code, NFPA 70. The connectors may be constructed so that they are also acceptable for use with copper conductor.

1.2 These requirements also cover ampere-rated connectors intended for use in appliances and equipment and that comply with the requirements specific to those appliances and equipment. Ampere-rated connectors are not intended for general use. Ampere-rated connectors are additionally evaluated for static temperature rise in the end-use application. Ampere-rated connectors shall be identified as such by the appropriate marking requirements. See 21.21.

1.3 These requirements cover:

a) Terminal-type wire connectors intended for use with No. 12 AWG (3.3 mm^2) or larger aluminum or copper-clad aluminum conductor, including those designated also for No. 30 AWG (0.05 mm^2) or larger copper conductor, and

b) Splicing-type wire connectors intended for use with No. 4 AWG (21.2 mm^2) or larger conductors, with currents not exceeding the ampacity of insulated conductors rated 75°C or 90°C in accordance with the connector rating and not exceeding the maximum current rating – if provided – of the connector. A splicing connector may have a conductor range that includes sizes smaller than No. 4 AWG. For connectors intended for use with stranded conductors, the following conductor strand configurations are intended:

- 1) Aluminum – Class B concentric, compressed, and unidirectional lay compact.
- 2) Copper – Class B concentric and compressed, Class C concentric.
- 3) Copper-Clad Aluminum – Class B concentric.

Other class and strand configurations may also be covered as indicated by marking.

1.3.1 These requirements also cover connectors of the types specified in 1.3 intended for use with metric conductors that have cross sectional area within the range of the rated AWG/kcmil conductors. For example, a connector rated for 6 AWG – 250 kcmil may additionally be rated for 16 – 120 mm^2 . See 6.1.13, 7.2.2.1, 21.26, and 21.27.

1.3.1 added May 22, 2000

1.4 These requirements cover insulated connectors, insulating caps, and covers intended for use at 600 volts or less [1000 volts in a sign or lighting fixture (luminaire)] and uninsulated connectors for use in general-use circuits rated 2000 volts nominal or less.

Exception: Uninsulated pressure wire connectors (both terminal and splicing type) that are compression tool applied may be used in circuits rated 35,000 volts or less. When connectors are used in such circuits, the stress-relief insulation prescribed by the manufacturers of shielded cables is to be provided when these connectors are installed.

1.5 These requirements also cover connectors additionally rated for No. 2 AWG (33.6 mm²) and larger compact-stranded copper conductors. These connectors are identified in accordance with 21.8. See also 3.2 and the Exception to 7.2.7(b) (3).

1.5 revised May 22, 2000

1.6 These requirements do not cover connectors intended for direct burial, insulated connectors intended for use at voltage levels in excess of 600 volts [1000 volts in a sign or lighting fixture (luminaire)], manually applied screw-on connectors, binding-screw terminals, built-in terminal connectors on devices rated under 30 amperes and intended for outlet-box mounting or having provision for strain relief, or built-in terminal connectors on devices having integral cable clamps.

1.7 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.7 revised May 22, 2000

2 General

2.1 Units of measurement

2.1.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.1.1 revised May 22, 2000

2.2 Undated references

2.2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

CONSTRUCTION

3 General

3.1 The construction of a connector intended for use with stranded conductor shall be such that all strands of the conductor will be contained within the connector.

3.2 A connector tested with a compact stranded aluminum and/or copper conductor according to these requirements shall also accept all strands of a Class B concentric stranded conductor of the same size and type.

3.3 The clamping movement of a connector shall adapt it for use with conductors of different sizes without permanent removal or addition of parts, when such use is intended. Examples of clamping means 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 specific tool, or
- d) A nut threading onto a split bolt.

Any rearrangement or adjustment of a connector that is necessary to adapt it to various sizes of the conductor shall be obvious unless the connector is marked as required by 21.6.

3.4 If the method of mounting an equipment terminal connector is such that the mounting means cannot be retightened after conductors are installed, or after the connector is mounted in equipment, the mounting means – by inherent features or manufacturer's specifications – shall limit rotation of the connector around its mounting means to 30 degrees maximum.

3.5 There shall be no sharp edges or corners on the outer surface of a connector that would be likely to damage insulation that it may contact.

3.6 The construction of a connector intended to secure more than a single conductor shall be such that there will be no intermixing (direct contact) between the conductors of different materials unless the connector is investigated and marked for intermixing - dry locations only. See 6.1.12, 6.2.3, 6.3.2, and 21.5.

3.6 effective October 16, 1998

4 Materials

4.1 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 be acceptable for the purpose.

4.2 A connector body of copper, copper alloy, aluminum, or aluminum alloy shall be coated with an electrically conductive coating that will inhibit oxidation and corrosion.

Exception No. 1: A splicing connector that is shipped prefilled with an oxide-inhibiting compound need not be coated.

Exception No. 2: The conductor securing (barrel) portion of a terminal connector that is shipped prefilled with an oxide-inhibiting compound need not be coated.

Exception No. 3: An aluminum bodied splicing connector intended for an aluminum conductor only; not copper-clad aluminum need not be coated.

Exception No. 4: The saw-cut ends of a neutral bar need not be coated.

Exception No. 5: The top cap of a lay-in lug or connector not in contact with the wire need not be plated.

Exception No. 6: A stamped mounting hole in a connector which is intended to be secured by a bolt, nut, and washer need not be plated.

4.3 Tin is acceptable for the coating mentioned in 4.2. Other coatings may be acceptable if found by investigation to be acceptable for the purpose.

4.4 A brass part of a connector shall be resistant to stress corrosion cracking.

4.5 A brass part containing not more than 15 percent zinc is considered to be resistant to stress corrosion cracking.

4.6 A brass part containing more than 15 percent zinc shall comply with 10-Day Moist Ammonia-Air Stress Cracking Test, Section 20.

4.7 Iron or steel, if protected against corrosion by zinc or nickel plating or an equivalent 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.

4.8 Insulation employed as a part of a connector shall be porcelain, cold-molded or phenolic composition, or other material that has been investigated and found to be acceptable for 75°C or 90°C according to the intended use of the connector. See 21.16.

4.8.1 The insulating material is able to have a flammability classification as determined by tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. See 21.28.

4.8.1 added May 23, 2001

4.9 Insulation consisting of natural or GR-S rubber or a thermoplastic material may be subjected to an appropriate investigation to determine if it is acceptable for the purpose.

4.10 Porcelain or cold-molded composition used as insulation shall additionally comply with Moisture Absorption Test, Section 19.

PERFORMANCE

5 General

5.1 A connector shall perform acceptably when separate sets of samples are subjected to the tests specified in Tables 5.1 – 5.3.

Exception No. 1: A connector of copper or copper alloy need not be subjected to the heat-cycling sequence with copper conductor.

Exception No. 2: The initial static-heating test need not be conducted in the static-heating sequence using copper conductor.

Exception No. 3: For other than a tool-applied crimp connector, the heat-cycling test using copper conductor need not be conducted provided the connector has been heat-cycling tested with aluminum conductor of a size not smaller than the size of copper conductor which would otherwise be required for the heat-cycling test.

Example No. 1: A setscrew connector is rated 4 AWG – 250 kcmil CU/AL. The conductor sizes required for heat-cycling testing are 250 kcmil CU and 250 kcmil AL. In accordance with Exception No. 3 above, the heat-cycling test using copper conductor need not be conducted because the size of aluminum conductor to be heat-cycling tested is not smaller than the size of

copper conductor.

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Example No. 2: A setscrew connector is rated 4 AWG – 250 kcmil CU, 4 – 1/0 AWG AL. The conductor sizes required for heat-cycling testing are 250 kcmil CU and 1/0 AWG AL. As the size of aluminum conductor to be tested is smaller than the size of copper conductor, Exception No. 3 above would not apply and the heat-cycling test would need to be conducted for both copper and aluminum conductor.

Exception No. 4: Nos. 30 – 20 AWG (0.05 – 0.52 mm²) conductors need not be subjected to the secureness test.

Table 5.1
Test sequence for insulated connectors

1	2	3 ^a	4
Dielectric voltage- withstand	Secureness of insulation	Drop dielectric voltage- withstand after drop	Flexing
^a Connectors intended for No. 2 AWG (33.6 mm ²) or larger conductor.			

Table 5.2
Test sequence for all connectors intended for a single conductor

1	2 ^a	3 ^b
Heat cycling	Static heating secureness ^c static heating pullout	Secureness ^c pullout
^a This series of tests is referred to as static-heating sequence.		
^b This series of tests is referred to as mechanical sequence.		
^c Conductor size Nos. 30 – 20 AWG (0.05 – 0.52 mm ²) are not subject to a secureness test.		

Table 5.3
Test sequence for all connectors intended for paralleling conductors

Static heating	Heat cycling	Secureness ^a pullout
^a This series of tests is referred to as mechanical sequence.		

5.2 As a result of the tests, there shall be no breakage of the conductor or any strand of a stranded conductor, stripping of threads, shearing of parts, or other damage to the connector. The insulation of an insulated connector shall not crack or break when the connector is assembled as intended on the conductor.

5.3 With reference to 5.2, breaking of the conductor or any strand of a stranded conductor is to be determined by examination of the complete connector assembly while still intact after the secureness and pullout tests. If the conductor or a strand of a stranded conductor becomes visibly unattached, breakage is considered to have occurred.

5.4 The oven conditioning described in 14.2.2 and 14.2.3 and Table 14.3 shall not cause the connector insulation to harden, soften, crack, deform, loosen, or otherwise change so as to adversely affect the insulating properties of the conductor insulation or the connector insulation. However, discoloration of the connector insulation is acceptable.

6 Selection of Samples

6.1 General

6.1.1 Separate samples are to be used for the heat-cycling, mechanical sequence, static-heating sequence, and the dielectric voltage-withstand test.

6.1.2 The basic sample set for heat-cycling tests, mechanical sequence, and static-heating sequence is to consist of four connectors for each combination of connector and test conductor or conductors to be tested.

Exception No. 1: For testing a splicing connector or run and tap connector in which each conductor is secured by a separate means, the sample set is to consist of two connectors for each combination of connector and test conductor to be tested.

Exception No. 2: For a connector intended for a conductor size range of No. 14 – 10 AWG (2.1 – 5.3 mm²) copper and Nos. 12 and 10 AWG (3.3 and 5.3 mm²) aluminum, the basic sample set for the static-heating sequence may consist of two connectors for each combination of connector and test conductor to be tested.

Exception No. 3: For a neutral bar, the basic sample set is to consist of a double set of three connector holes cut from a length of the neutral bar. The distance between the holes cut from the neutral bar is to be representative of the minimum distance provided in production. See 11.2.

6.1.3 The number of samples required for the dielectric voltage-withstand tests is specified in Dielectric Voltage-Withstand Test, Section 14.