



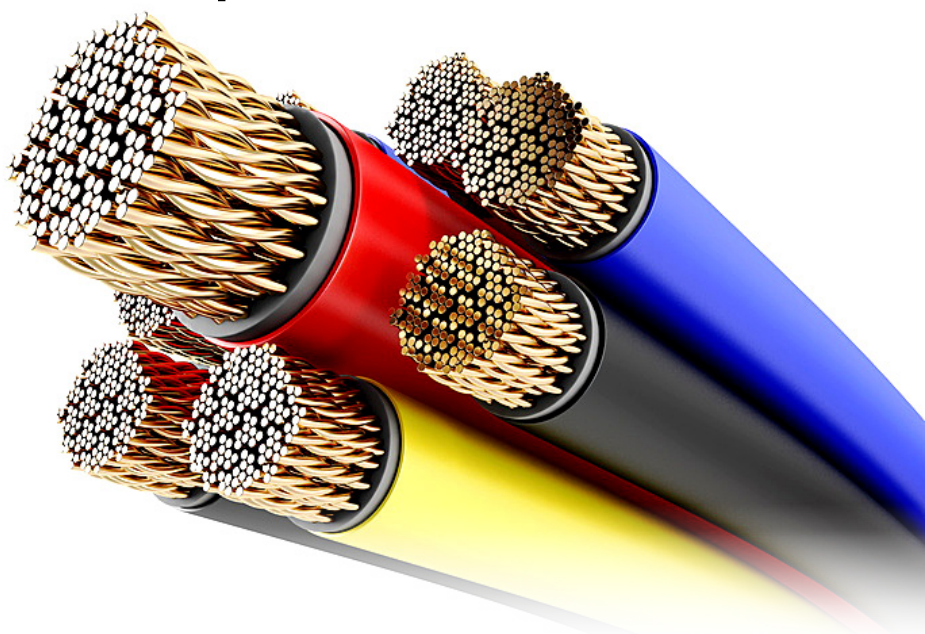
ELECTRICAL CONNECTIONS

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Tools and Tips for Assessing Compliance with Fine Stranded Cable Termination Requirements

Section 110.14 of the 2011 edition of the National Electric Code (NEC) has added new language specifically requiring that lugs and terminals used to terminate conductors — also known as “fine stranded conductors” — are to be identified for a specific conductor class. Under the NEC, any conductor with more strands than a Class C stranded conductor must be terminated in a manner that identifies the conductor class.



This additional language is consistent with clause 10.12 of UL 486A-B, the Standard for Safety for Wire Connectors, requiring that connectors for other than Class B or C stranding be marked with the conductor class and number of strands. With UL's permission, a portion of UL 486A-B is reproduced in chapter 9 table 10 of the 2011 NEC so this requirement can be applied in the field (see table “Conductor Stranding” located on page 2).

Fine stranded cable has already been used with photovoltaic systems, so requirements similar to section 110.14 can also be found in sections 690.31(F) and 690.74 in the 2008 NEC. In the 2011

NEC, sections 690.31(F) and 690.74(A) simply identify that flexible fine stranded cable shall be terminated in accordance with 110.14(A). Fine stranded cable can also be found in use with wind turbine systems and battery systems.

Because 2011 NEC section 110.14(A) requires terminals and lugs intended for use with fine stranded cable shall be identified for a specific class of conductor, some code authorities may have questions about how to identify them. This information can be found in category ZMVV (Wire Connectors and Soldering Lugs) in the UL White Book. Category ZMVV states:

Stranded conductor Class — Connectors rated for use with stranded conductors are for the following strand configurations:

- **Aluminum** — Class B concentric, compressed or compact, and SIW (single input wire)
- **Copper-clad aluminum** — Class B concentric or compressed, and Class C concentric
- **Copper** — Class B concentric or compressed, and Class C concentric

Wire connectors additionally rated for use with compact copper conductors are additionally marked “For compact-stranded

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Fine Stranded Cable Termination Requirements (continued)

copper conductors” or equivalent on the connector or on or within the unit container.

Wire connectors additionally rated for use with other Class conductors, such as Class M, are marked with the additional class designation and number of strands.

UL category ZMVV also contains additional information that is very helpful to installers and inspectors when selecting or verifying that proper terminations have been used:

- **Multiple conductors** — Connectors generally accommodate a single conductor under a clamping mechanism unless otherwise identified, such as with the number of conductors located parenthetically in front of the wire size or range. Some connectors may have a single-conductor wire range as well as a second multiple-conductor wire range. Some connectors, such as twist-on connectors, will have multiple conductors expressed in a list of wire combinations.
- **Conductor material** — Wire connectors or the unit containers are marked with the type of conductor material(s) as shown in the table titled Conductor Material.

It’s critical to review carefully the information contained in the “For Use With” column in the table. Typically, aluminum conductors are not intended to be used in direct physical contact with copper and copper-clad aluminum conductors within the same connector. However, a wire connector intended for securing an aluminum wire in combination with a copper or copper-clad aluminum conductor when wires of different metals are in physical contact with each other is limited to dry locations only and is marked “AL-CU (intermixed — dry locations).”

Finally, NEC section 110.3(B) requires that listed equipment shall be installed and used in accordance with any instructions included in the listing. To comply with the requirements of 110.3(B), refer to the UL White Book category ZMVV.

For more information about UL certified wire connectors and lugs, please contact Jeff Fecteau at +1.952.838.5453 or at Jeffrey.Fecteau@us.ul.com.

Conductor Stranding

Size of conductor to which connector is to be assembled		Number of strands, if stranded conductors				
		Copper		Aluminum	Copper — clad aluminum	
AWG or kcmil	(mm ²)	Class B	Class C	Class B	Class B	Class C
24–30	(0.20–0.05)	^a	—	—	—	—
22	(0.32)	7	—	—	—	—
20	(0.52)	10	—	—	—	—
18	(0.82)	16	—	—	—	—
16	(1.3)	26	—	—	—	—
14–2	(2.1–33.6)	7	19	7 ^b	7 ^b	19 ^b
1–4/0	(42.4–107)	19	37	19	19	37
250–500	(127–253)	37	61	37	37	61
600–1,000	(304–508)	61	91	61	61	91
1,250–1,500	(635–759)	91	127	91	91	127
1,750–2,000	(886–1 016)	127	271	127	127	271

^aNumber of strands vary.

^bAluminum and copper-clad aluminum 14 AWG (2.1 mm²) are not available.

Source: UL 486A-B (Table 14) and 2011 NEC® Chapter 9 (Table 10)

Conductor Material

Marking (or equivalent)	For Use With
“CU”	Copper wire only
“AL”	Aluminum wire only
“AL-CU” or “CU-AL”	Copper to copper, aluminum to aluminum, copper to aluminum but not intermixed or in direct physical contact, copper-clad aluminum to copper-clad aluminum, copper to copper-clad aluminum, aluminum to copper-clad aluminum but not intermixed or in direct physical contact
“AL-CU (intermixed — dry locations)”	Copper to copper, aluminum to aluminum, copper to aluminum intermixed and in direct physical contact, copper-clad aluminum to copper-clad aluminum, copper to copper-clad aluminum, aluminum to copper-clad aluminum and in direct physical contact