



UL 1569

STANDARD FOR SAFETY

Metal-Clad Cables

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UL Standard for Safety for Metal-Clad Cables, UL 1569

Fourth Edition, Dated November 13, 2014

SUMMARY OF TOPICS:

This new edition of ANSI/UL 1569 is being issued to incorporate the following changes in requirements:

Revision to expand the AWG range for stranded conductors permitted to be Butt spliced

Revisions to include corrugated stainless steel armor

Addition of requirements to include an optional binder jacket

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 6, 2014 and September 12, 2014.

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UL 1569

Standard for Metal-Clad Cables

First Edition – July, 1983
Second Edition – May, 1995
Third Edition – August, 1999

Fourth Edition

November 13, 2014

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

The most recent designation of ANSI/UL 1569 as an American National Standard (ANSI) occurred on November 13, 2014. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

The Department of Defense (DoD) has adopted UL 1569 on July 23, 1983. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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CONTENTS

INTRODUCTION

1 Scope	7
2 Units of Measurement	8
3 Undated References	8

CONSTRUCTION

4 General	8
5 Materials	8
6 Conductors	8
6.1 General	8
6.2 Compact-stranded sector conductors	14
7 Circuit Conductors	15
7.1 General	15
7.2 NEC types	15
7.3 Other insulated conductors	17
7.4 Insulated sector conductors	17
8 Optical Fiber Members	17
9 Assembly	18
9.1 Optical-fiber member(s)	18
9.2 Circuit and grounding conductors	18
9.3 Binders	20
10 Fillers	21
11 Shields	21
12 Covering Under Armor	21
13 Armor	25
14 Covering Over Armor	26

PERFORMANCE

15 Continuity Test of Conductors	27
16 Test of Zinc Coating on Steel Armor	28
17 Deformation Test of Thermoplastic and XL Jackets	30
18 Test for Tightness of Armor on Conductors	30
19 Flexibility Test	31
20 Cold-Bend Test	32
21 Cold-Impact Test	32
22 Dielectric Voltage-Withstand Test	32
23 Tension Test	34
24 Impact Test	36
25 Crushing Test – All Cable	38
26 Crushing Test – Cable Marked for Direct Burial	39
27 Fault-Current Test	40
28 Overload Current Tests	43
29 Cable Flame Test (Overall Jacket in Place)	44
30 Vertical-Tray Flame Tests on Cables	44
30.1 General	44
30.2 UL test	44
30.3 FT4/IEEE 1202 test	45

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31	Vertical-Tray Fire and Smoke Release Test for Jacketed Cables with Optional "ST1" Marking	.45
32	Sunlight-Resistance Test	.45
33	Test for Mechanical Water Absorption	.45
34	Test for Surface Print on Inner and Overall Jackets	.46

MARKINGS

35	Intervals	.46
36	Re-identified Cable Core	.46
37	Color of Insulated Grounding Conductor	.47
38	Identification of Ungrounded Circuit Conductor(s)	.47
39	Identification of Grounded Circuit Conductor(s)	.47
40	On or in the Cable	.48
41	On the Tag, Reel, or Carton	.50
42	Date of Manufacture	.53
43	Insulated Equipment-Grounding Conductors	.53
44	Isolated-Grounding Conductors	.55
45	Copper-Clad Aluminum	.56
46	Aluminum	.56
47	Compact-Stranded Copper Conductors	.57
48	Responsibility for the Insulated Conductors	.57
48.1	No identification needed	.57
48.2	Only factory identification needed	.57
48.3	Organization and factory identification needed	.57
49	Dual Marking	.58
50	Installation Instructions	.58

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INTRODUCTION

1 Scope

1.1 These requirements cover round or flat metal-clad cables that contain 18 AWG – 2000 kcmil insulated circuit conductors with or without one or more optical-fiber members, all enclosed in armor consisting of interlocked metal strip or a smooth or corrugated metal tube. Round cables contain one or more insulated circuit conductors. Flat cable contains two or three insulated circuit conductors. These electrical and hybrid electrical/optical-fiber cables are for use (optical and electrical functions associated in the case of a hybrid cable) as Type MC cable in accordance with Article 330 and other applicable parts of the National Electrical Code, NFPA 70.

1.2 These requirements cover round or flat armored cables that have thermoplastic or thermoset insulation and are for use at potentials not exceeding 600 V (thermoplastic) or 600 or 2000 V (thermoset) where subjected to temperatures not exceeding 75°C (167°F) or 90°C (194°F), depending upon the voltage and temperature ratings of the circuit conductors in the cable. Cables with 600 V conductors that also include one or more optical-fiber members have “-OF” supplementing the type letters and are limited to carrying optical energy that has been ruled not hazardous to the human body.

1.3 Type MV (medium-voltage) cables rated for 2400 – 35000 V are covered in separate requirements. A multiple-conductor Type MV cable with a smooth (other than lead) or corrugated metal sheath or with interlocked metal armor may be marked for use also as Type MC cable.

1.4 These requirements do not cover Type AC armored cables (see the Standard for Armored Cables, UL 4). Metal-clad cables for use in Division 1 and Zone 1 hazardous locations are required to comply with this Standard and the Standard for Metal-Clad Cables and Cable-Sealing Fittings for Use in Hazardous (Classified) Locations, UL 2225.

1.5 These requirements do not cover the optical or other performance of any optical-fiber member or group of such members. See 8.3.

1.6 A cable to which the designation “ST1” (signifying “limited smoke”) is applied as a type-letter suffix, complies with the test criteria for smoke release and for cable damage height stated in the Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685. See Section 30, Vertical-Tray Fire and Smoke Release Test for Jacketed Cables with Optional “ST1” Marking (test requirement) and 40.1 (marking requirement).

2 Units of Measurement

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

3 Undated References

3.1 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

4 General

4.1 Metal-clad cable shall be designated as Type MC and shall comply in all respects with the applicable requirements for construction details, test performance, and markings.

4.2 The insulation in each of the following cables shall be of a material that is acceptable for use in wet locations if the cable has armor consisting of interlocked metal strip but does not include a jacket over the assembly under the armor:

- a) Cable that is marked for direct burial; and
- b) Cable that is intended for use in wet locations.

5 Materials

5.1 Only materials that are acceptable for the particular use shall be employed in a cable.

6 Conductors

6.1 General

6.1.1 Only copper, copper-clad aluminum, or an acceptable aluminum alloy shall be used for the conductors in a cable. Soft-annealed copper shall comply with the Standard Specification for Soft or Annealed Copper Wire, ASTM B 3. Solid aluminum conductors in size 12 – 8 AWG shall comply with the requirements for aluminum-wire stock (aluminum-alloy conductor material). All other aluminum conductors shall comply with the requirements for semi-annealed 8000 series aluminum conductors in Section 10, Requirements for Aluminum Conductors of an 8000 Series Alloy of the Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581. Copper-clad aluminum conductors shall comply with the requirements in Section 11, Requirements for Copper-Clad Aluminum Conductors of UL 1581. In a given cable, all conductors are not required to be of the same metal.

6.1.2 A copper conductor shall not be smaller than 18 AWG and shall not be larger than 2000 kcmil. An aluminum or copper-clad aluminum conductor shall not be smaller than 12 AWG and shall not be larger than 2000 kcmil.

6.1.3 Each 6 AWG – 2000 kcmil conductor shall be stranded. Copper conductors which are 18 or 16 AWG shall comply with the requirements for fixture wire conductors in the Standard for Fixture Wire, UL 66. The 14 AWG and larger copper, or 12 AWG and larger aluminum conductors shall comply with the requirements in 4.1, Conductors of the Standard for Thermoset-Insulated Wires and Cables, UL 44, or in 4.1, Conductors of the Standard for Thermoplastic-Insulated Wires and Cables, UL 83, except as modified in this Section.

6.1.4 Any joint in a conductor shall comply with the applicable Standard indicated in 7.2.1, except that a splice is acceptable in an 18 – 8 AWG stranded conductor as a whole if the splice (butt splice) is made by machine brazing or welding such that the resulting solid section of the stranded conductor is not longer than 1/2 inch (13 mm), the splice does not increase the diameter of the conductor, there are no sharp points, and the distance between splices in a single conductor does not average less than 3000 ft (915 m) in any reel length of that single insulated conductor. A butt splice shall be made before insulating or after insulating and prior to further processing. Butt splices of stranded conductors made after insulating and splices of insulated solid conductors made with other than the original insulation shall be the subject of an investigation that includes tests to determine that all electrical, physical, and mechanical properties of the original system of insulation and any jacket on the conductor have been restored at the point of each splice. All finished, insulated stranded conductors containing a butt splice or splice made with other than the original insulation shall not be marked as an NEC type but the following are acceptable:

- a) Polarity Identification – Color coding, surface printing, or both, of hash marks, numbers, color names, or the like.
- b) Ratings On Non-Nec Conductors – Surface marking of the 41.1(c)(1) temperature and dry/wet ratings from Table 9.1.

6.1.5 Cable having interlocked armor, not intended to be used as a ground path, shall contain one copper, aluminum, or copper-clad aluminum grounding conductor that is in one location or in several sections (see 6.1.9) and is not smaller than indicated under the heading "Grounding Conductor" in Table 6.1 or 6.3 [90°C (194°F) circuit conductors] or in Table 6.2 or 6.4 [75°C (167°F) circuit conductors]. One or more additional copper, aluminum, or copper-clad aluminum grounding conductors may be provided. See Table 9.1 for appropriate wet and dry ratings. Each additional grounding conductor shall not be sectioned and shall not be smaller than indicated in Table 6.1 or 6.2. If only one grounding conductor is provided, it may be bare or it may be insulated in accordance with 40.1. If more than one grounding conductor is provided, one grounding conductor (the required conductor) may be bare or insulated and every other grounding conductor shall be insulated in accordance with 43.2 or 43.3. See 6.1.11.

6.1.6 Cable with 14 – 6 AWG insulated conductors having interlocked armor that is intended for use as a ground path, shall contain a bare aluminum grounding/bonding conductor cabled with the insulated conductors. Cable with interlocked armor and a binder tape in accordance with 12.1 – 12.5 shall have the grounding/bonding conductor positioned over the binder tape and located in one of the interstices and in direct contact with the interlocked armor. Cable with interlocked aluminum or zinc-coated steel armor and insulated conductors with a protective covering in accordance with 12.6 shall have the bare aluminum grounding/bonding conductor cabled with the insulated conductors and in direct contact with the interlocked armor. See Table 9.1 for appropriate wet and dry ratings. The grounding/bonding conductor shall not be smaller than indicated under the heading "Grounding Conductor" in Table 6.1 [90°C (194°F) circuit conductors] or in Table 6.2 [75°C (167°F) circuit conductors] and shall not be sectioned. One or more additional copper, aluminum, or copper-clad aluminum grounding conductors may be provided. Each additional grounding conductor shall not be sectioned and shall not be smaller than indicated in Table 6.1 or 6.2. If an additional grounding conductor is provided, it shall be insulated in accordance with 43.1 – 43.3. See 6.1.11.

6.1.7 Cable having corrugated- or smooth-sheath armor with a resistance greater than indicated in one of the last four columns of Table 6.1 or 6.3 [90°C (194°F) circuit conductors] or in Table 6.2 or 6.4 [75°C (167°F) circuit conductors] shall contain one copper, aluminum, or copper-clad aluminum grounding conductor that is in one location or in several sections (see 6.1.9) and is of a size such that the measured resistance (see 6.1.10) of the grounding conductor in parallel with the armor is not higher than indicated in one of the last four columns of Table 6.1 or 6.2. One or more additional copper, aluminum, or copper-clad aluminum grounding conductors may be provided. Each additional grounding conductor shall not be sectioned and shall not be smaller than indicated in Table 6.1 or 6.2. If only one grounding conductor is provided, it shall be bare or it shall be insulated in accordance with 43.1. If more than one grounding conductor is provided, one grounding conductor (the required conductor) shall be bare or insulated and every other grounding conductor shall be insulated in accordance with 43.2 or 43.3. See 6.1.11.

6.1.8 Cable having corrugated- or smooth-sheath armor that has a resistance equal to or lower than indicated in one of the last four columns of Tables 6.1 – 6.4 may contain one or more copper, aluminum, or copper-clad aluminum grounding conductors. Each grounding conductor shall not be smaller than indicated under the heading "Grounding Conductor" in Table 6.1 [90°C (194°F) circuit conductors] or in Table 6.2 [75°C (167°F) circuit conductors]. If only one grounding conductor is provided, it may be bare and may be sectioned (see 6.1.9) or it may be insulated in accordance with 43.1. If more than one grounding conductor is provided, one grounding conductor may be bare and may be sectioned (see 6.1.9) and every other grounding conductor shall not be sectioned and shall be insulated in accordance with 43.2 or 43.3. See 6.1.11.

Table 6.1
Smallest acceptable grounding conductor in cable containing 90°C (194°F) circuit conductors

Size of largest ungrounded circuit conductor		Grounding conductor		Maximum acceptable D-C resistance of ground path ^a			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest acceptable AWG size of unsectioned grounding conductor	Smallest acceptable AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor
18 AWG	—	18	—	7.06	23.2	7.19	23.6
17	—	17	—	5.59	18.3	5.70	18.7
16	—	16	—	4.45	14.6	4.53	14.9
15	—	15	—	3.44	11.3	3.51	11.5
14	12 AWG	14	12	2.73	8.96	2.78	9.14
13	11	13	11	2.16	7.10	2.20	7.24
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10 – 8	8 – 6	10	8	1.080	3.546	1.102	3.615
7 – 4	5 – 2	8	6	0.6795	2.230	0.6929	2.274
3 – 2/0	1 – 3/0	6	4	0.4276	1.403	0.4359	1.430
3/0 AWG – 250 kcmil	4/0 AWG – 350 kcmil	4	2	0.2689	0.8820	0.2742	0.8993
300 – 400	400 – 600	3	1	0.2132	0.6996	0.2175	0.7133
450 – 650	700 – 1000	2	1/0	0.1691	0.5548	0.1724	0.5657

Table 6.1 Continued

Size of largest ungrounded circuit conductor		Grounding conductor		Maximum acceptable D-C resistance of ground path ^a			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest acceptable AWG size of unsectioned grounding conductor	Smallest acceptable AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor
700 – 900	1100 – 1500	1	2/0	0.1340	0.4398	0.1367	0.4485
1000 – 2000	1600 – 2000	1/0	3/0	0.1063	0.3487	0.1084	0.3556

^a Maximum acceptable DC resistance (1) of sectioned grounding conductor, (2) of corrugated- or smooth-sheath armor in cable without a required grounding conductor, and (3) of the parallel combination of required grounding conductor and armor in cable having corrugated- or smooth-sheath armor of higher resistance than indicated in the columns.

Table 6.2

Smallest acceptable grounding conductor in cable containing 75°C (167°F) circuit conductors

Size of largest ungrounded circuit conductor		Grounding conductor		Maximum acceptable D-C resistance of ground path ^a			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest acceptable AWG size of unsectioned grounding conductor	Smallest acceptable AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor
18 AWG	–	18	–	7.06	23.2	7.19	23.6
17	–	17	–	5.59	18.3	5.70	18.7
16	–	16	–	4.45	14.6	4.53	14.9
15	–	15	–	3.44	11.3	3.51	11.5
14	12 AWG	14	12	2.73	8.96	2.78	9.14
13	11	13	11	2.16	7.10	2.20	7.24
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10 – 7	8 – 5	10	8	1.080	3.546	1.102	3.615
6 – 3	4 – 1	8	6	0.6795	2.230	0.6929	2.274
2 – 3/0	1/0 – 4/0	6	4	0.4276	1.403	0.4359	1.430
4/0 AWG – 300 kcmil	250 – 450 kcmil	4	2	0.2689	0.8820	0.2742	0.8993
350 – 550	500 – 800	3	1	0.2132	0.6996	0.2175	0.7133
600 – 800	900 – 1300	2	1/0	0.1691	0.5548	0.1724	0.5657
900 – 1300	1400 – 2000	1	2/0	0.1340	0.4398	0.1367	0.4485
1400 – 2000	–	1/0	3/0	0.1063	0.3487	0.1084	0.3556

Table 6.2 Continued

Size of largest ungrounded circuit conductor		Grounding conductor		Maximum acceptable D-C resistance of ground path ^a			
		Copper	Aluminum or copper-clad aluminum				
Copper	Aluminum or copper-clad aluminum	Smallest acceptable AWG size of unsectioned grounding conductor	Smallest acceptable AWG size of unsectioned grounding conductor	20°C (68°F)		25°C (77°F)	
				Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor
^a Maximum acceptable DC resistance (1) of sectioned grounding conductor, (2) of corrugated- or smooth-sheath armor in cable without a required grounding conductor, and (3) of the parallel combination of required grounding conductor and armor in cable having corrugated- or smooth-sheath armor of higher resistance than indicated in the columns.							

Table 6.3

Smallest acceptable grounding conductor in cable containing one 90°C (194°F) circuit conductor

Size of the circuit conductor		Grounding conductor		Maximum acceptable D-C resistance of ground path ^a			
		Copper	Aluminum or copper-clad aluminum	20°C (68°F)		25°C (77°F)	
Copper	Aluminum or copper-clad aluminum	Smallest acceptable AWG size of unsectioned grounding conductor	Smallest acceptable AWG size of unsectioned grounding conductor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10	8	10	8	1.080	3.546	1.102	3.615
8	6	8	6	0.6795	2.230	0.6929	2.274
6 – 2	4 – 1	6	4	0.4276	1.403	0.4359	1.430
1 – 2/0	1/0 – 3/0	4	2	0.2689	0.8820	0.2742	0.8993
3/0	4/0 – 300	3	1	0.2132	0.6996	0.2175	0.7133
4/0 – 250	350 – 400	2	1/0	0.1691	0.5548	0.1724	0.5657
300 – 350	500	1	2/0	0.1340	0.4398	0.1367	0.4485
400 – 600	600 – 900	1/0	3/0	0.1063	0.3487	0.1084	0.3556
700 – 900	1000	2/0	4/0	0.08432	0.2766	0.08598	0.2820
1000	–	3/0	–	0.06688	0.2194	0.06820	0.2238
^a Maximum acceptable DC resistance (1) of sectioned grounding conductor, (2) of corrugated- or smooth-sheath armor in cable without a required grounding conductor and (3) of the parallel combination of required grounding conductor and armor in cable having corrugated- or smooth-sheath armor of higher resistance than indicated in the columns.							

Table 6.4
Smallest acceptable grounding conductor in cable containing one 75°C (167°F) circuit conductor

Size of the circuit conductor		Grounding conductor		Maximum acceptable D-C resistance of grounding path ^a			
		Copper	Aluminum or copper-clad aluminum	20°C (68°F)		25°C (77°F)	
Copper	Aluminum or copper-clad aluminum	Smallest acceptable AWG size of unsectioned grounding conductor	Smallest acceptable AWG size of unsectioned grounding conductor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor	Ohms based on 1000 feet of armor	Ohms based on 1 kilometer of armor
12	10	12	10	1.72	5.64	1.75	5.75
11	9	11	9	1.37	4.48	1.39	4.56
10 – 7	8	10	8	1.080	3.546	1.102	3.615
6	6 – 4	8	6	0.6795	2.230	0.6929	2.274
4 – 1	3 – 1/0	6	4	0.4276	1.403	0.4359	1.430
1/0 – 2/0	2/0 – 4/0	4	2	0.2689	0.8820	0.2742	0.8993
3/0 – 4/0	250 – 350	3	1	0.2132	0.6996	0.2175	0.7133
250 – 300	400 – 500	2	1/0	0.1691	0.5548	0.1724	0.5657
350 – 400	600 – 700	1	2/0	0.1340	0.4398	0.1367	0.4485
500 – 750	750 – 1000	1/0	3/0	0.1063	0.3487	0.1084	0.3556
800 – 1000	—	2/0	—	0.08432	0.2766	0.08598	0.2820

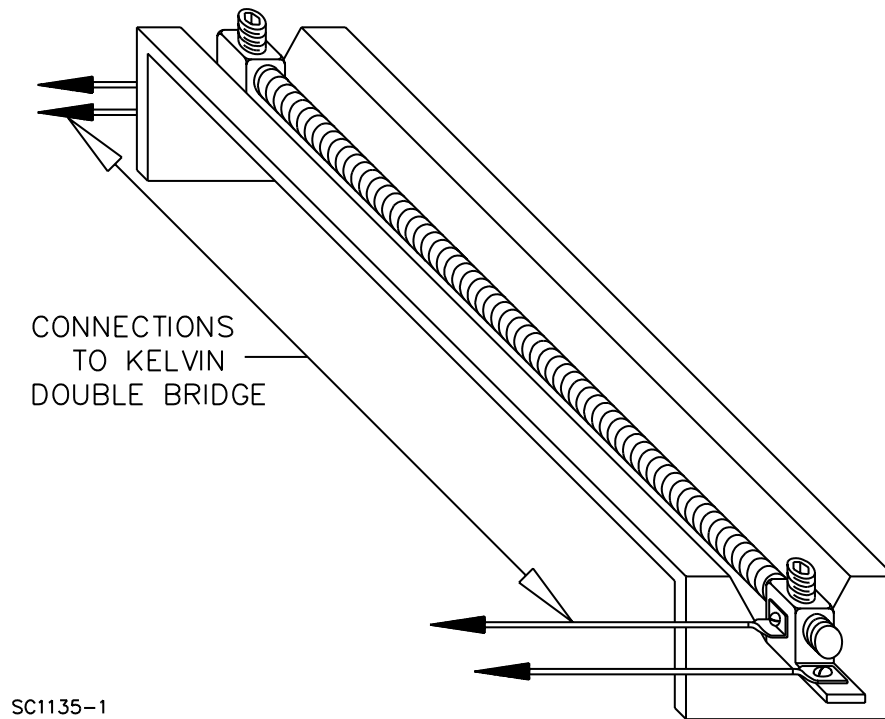
^a Maximum acceptable DC resistance (1) of sectioned grounding conductor, (2) of corrugated- or smooth-sheath armor in cable without a required grounding conductor and (3) of the parallel combination of required grounding conductor and armor in cable having corrugated- or smooth-sheath armor of higher resistance than indicated in the columns.

6.1.9 A grounding conductor in a multiple-conductor cable shall not be distributed helically (concentric). A copper grounding conductor smaller than 14 AWG shall not be sectioned. No part of a sectioned grounding conductor shall be smaller than 18 AWG.

6.1.10 The resistance of corrugated- or smooth-sheath armor, and any grounding conductor required to parallel the armor as described in 6.1.7, and the resistance of the interlocked aluminum or zinc-coated steel armor and bare grounding/bonding conductor described in 6.1.6, is to be determined by placing a length of the finished cable in a wooden, V-shaped trough having stud-type wire connectors at the ends (spaced 10 ft or 3048 mm between centers) as shown in Figure 6.1. The ends of the armor and any required grounding conductor are to be secured firmly in the wire connectors. The required grounding conductor is to be folded around each end of the armor and gripped against the armor by the wire connectors. The wires of a stranded grounding conductor are to be spread out somewhat to result in maximum contact. Any additional insulated grounding conductors in the cable are to be disregarded. Leads are to be brought out to a Kelvin double-bridge ohmmeter that has a range of 0.001 – 11 ohms and is accurate to within 2 percent of the value read. The resistance of the armor and any required grounding conductor is to be read directly in ohms.

6.1.11 Grounding-conductor insulation and any covering over that insulation shall comply with Circuit Conductors, Section 7, as if the insulated grounding conductor were a circuit conductor and shall comply with 9.2.1. Any or all additional insulated grounding conductors (these are insulated grounding conductors that are not required but are provided in accordance with 6.1.5, 6.1.7, or 6.1.8) may be designated as isolated-grounding conductors, with the outer surface of each such conductor marked as indicated in Isolated-Grounding Conductors, Section 44. See 9.2.4 (cabling) and 37.2 (color) and 41.1(k) (tag marking).

Figure 6.1
Apparatus for measuring resistance of armor and any required grounding conductor



6.2 Compact-stranded sector conductors

6.2.1 Compact-stranded, sector conductors shall be shaped as a 120 degree segment of a circle.

6.2.2 Compact-stranded, sector conductors shall comply with all of the requirements specified in 6.1, with the following exceptions:

- a) Sector conductors shall be limited to sizes 1/0 AWG – 750 kcmil.
- b) The conductor size shall be determined by the resistance method only per Section 220, D-C Conductor Resistance in the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.
- c) For purposes of calculating lay length, the effective diameter of the conductor shall be determined by adding the lengths of the conductor's major and minor axes and dividing by 2. The major axis is defined as the distance from top of the arc to bottom tip, and the minor axis is defined as the distance from left tip to right tip.
- d) Sector conductors are limited to copper only.

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7 Circuit Conductors

7.1 General

7.1.1 Each circuit conductor shall be either an NEC Type as shown in 7.2 or a non-NEC Type as shown in 7.3.

7.2 NEC types

7.2.1 Each circuit conductor that is available as a National Electrical Code type shall comply with this Standard and shall be one of the following types:

- a) 14 – 4/0 AWG and 250 – 2000 kcmil branch-circuit types complying with the Standard for Thermoset-Insulated Wires and Cables, UL 44, or the Standard for Thermoplastic-Insulated Wires and Cables, UL 83:

Type(s)	Ratings for Type MC application	UL Standard
FEP	200°C (392°F) dry 600 V special applications or 90°C (194°F) dry 600 V	83
RHH	90°C (194°F) dry 600 V or 2 kV	44
SA	200°C (392°F) dry 600 V special applications or 90°C (194°F) dry 600 V	44
RHW-2	90°C (194°F) wet or dry 600 V or 2 kV	44
RHW	75°C (167°F) wet or dry 600 V or 2 kV	44
RHH or RHW	90°C (194°F) dry 75°C (167°F) wet 600 V or 2 kV	44
XHHW-2	90°C (194°F) wet or dry 600 V	44
XHHW	90°C (194°F) dry 75°C (167°F) wet 600 V	44
XHH	90°C (194°F) dry 600 V	44
THHN	90°C (194°F) dry 600 V	83
THWN-2	90°C (194°F) wet or dry 600 V	83
THWN	75°C (167°F) wet or dry 600 V	83

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