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SUBJECT 2592

OUTLINE OF INVESTIGATION

FOR

Low Voltage LED Wire

Issue Number: 3

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Summary of Topics

This third issue of the Outline of Investigation for Low Voltage LED Wire, Subject 2592 has been revised to include requirements for parallel constructions.

The UL Foreword is no longer located within the UL Outline of Investigation. For information concerning the use and application of the requirements contained in this Outline of Investigation, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net.ul.com/ulforeword.html>.

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INTRODUCTION

1 Scope

1.1 These requirements cover single-conductor and multi-conductor, unjacketed, 18 – 10 AWG, low voltage LED wire rated 105°C – 250°C (221°F – 482°F), and 300 or 600 volts, suitable for installation in dry and damp, or wet locations. These wires are for use with signs, outline lighting, and interior lighting where the wire is only connected to a secondary circuit, is only accessible during user servicing and is not required to be additionally enclosed, in accordance with the Standard for Electrical Signs, UL 48.

1.2 Assemblies that include these wires and are intended for use as components of signs shall meet the requirements in the Standard for Electric-Sign Components, UL 879.

2 References

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.

3 Units of Measurement

3.1 In addition to being stated in the inch/pound units that are customary in the USA, each of the requirements in this standard is also stated in units that make the requirement conveniently usable in countries employing the various metric systems (practical SI and customary). Equivalent – although not necessary exactly identical – results are to be expected from applying a requirement in USA or in metric terms. Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

4 Materials

4.1 Each material used in a wire shall be compatible with all of the other materials used in the wire.

5 Conductors

5.1 Conductors

5.1.1 The conductor shall be stranded and shall be of soft-annealed copper. The conductor shall be 18 – 10 AWG in size. The conductor shall not be smaller in area than indicated in Table 5.1 and shall be continuous throughout without joints in the conductor as a whole. The conductor shall not be used where subjected to any temperature that exceeds that shown for the metal as shown in Table 5.2. The metal shall comply with the applicable ASTM specification as indicated in Table 5.2.

Table 5.1
Minimum cross-sectional area of conductor

AWG size of copper conductor	cmil (0.98 X nominal area)	mm ²
18	1,588	0.807
17	2,009	1.02
16	2,528	1.28
15	3,195	1.62
14	4,028	2.04
13	5,076	2.58
12	6,399	3.24
11	8,065	4.09
10	10,172	5.16

Table 5.2
Conductor – metal specifications

Conductor Metal	ASTM Reference	Temperature limit, °C (°F)
Copper, uncoated, each strand less than 0.015 inch (0.38 mm) in diameter	Standard Specification for Soft or Annealed Copper Wire, ASTM/ANSI B 3	150 (302)
Copper, uncoated, each strand at least 0.015 inch (0.38 mm) in diameter	Standard Specification for Soft or Annealed Copper Wire, ASTM/ANSI B 3	200(392)
Copper, tin-coated, each strand less than 0.015 inch (0.38 mm) in diameter	Standard Specification for Soft or Annealed Copper Wire, ASTM/ANSI B 3	150 (302)
Copper, tin-coated, each strand at least 0.015 inch (0.38 mm) in diameter	Standard Specification for Soft or Annealed Copper Wire, ASTM/ANSI B 3	200(392)
Copper, silver-coated	Standard Specification for Silver-coated Soft or Annealed Copper Wire, ASTM/ANSI B 298	200 (392)
Copper, nickel-coated	Standard Specification for Nickel-coated Soft or Annealed Copper Wire, ASTM/ANSI B 355	250 (482)
Copper, nickel-coated, 27 percent minimum nickel coated copper	Standard Specification for Nickel-coated Soft or Annealed Copper Wire, ASTM/ANSI B 355	550 (1022)

5.1.2 The size of a conductor shall be verified either by determination of the dc resistance or by determination of the cross-sectional area as described in 5.1.4. Measurement of the dc resistance is to be as described in the DC resistance test in the Standard for Wire and Cable Test Methods, UL 2556. Determination of the conductor size by measurement of the direct-current resistance is the referee method in all cases. The dc resistance shall not be higher than the maximum indicated for the size in Table 5.3 or 5.4, as applicable.

Table 5.3
Maximum direct-current resistance of copper conductors ASTM Class C 19-strand concentric-lay conductors

AWG size of conductor	Uncoated				Coated			
	20°C (68°F)		25°C (77°F)		20°C (68°F)		25°C (77°F)	
	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter
18	6.66	21.8	6.79	22.2	7.06	23.2	7.19	23.6
17	5.27	17.3	5.37	17.6	5.59	18.3	5.70	18.7
16	4.18	13.7	4.26	14.0	4.45	14.6	4.53	14.9
15	3.31	10.9	3.37	11.1	3.44	11.3	3.51	11.5
14	2.62	8.62	2.68	8.78	2.73	8.96	2.78	9.14
13	2.08	6.82	2.12	6.97	2.21	7.10	2.20	7.24
12	1.65	5.43	1.68	5.53	1.72	5.64	1.75	5.75
11	1.32	4.30	1.34	4.39	1.37	4.48	1.39	4.56
10	1.039	3.409	1.060	3.476	1.080	3.546	1.102	3.615

Table 5.4
Maximum direct-current resistance of single-bunch bunch-stranded copper conductors

AWG size of conductor	Uncoated				Coated			
	20°C (68°F)		25°C (77°F)		20°C (68°F)		25°C (77°F)	
	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter
18	6.72	22.1	6.85	22.5	7.23	23.7	7.36	24.6
17	5.29	17.4	5.40	17.7	5.47	17.9	5.57	18.3
16	4.18	13.7	4.26	14.0	4.54	14.9	4.58	15.0
15	3.30	10.8	3.37	11.1	3.44	11.3	3.50	11.5
14	2.63	8.64	2.67	8.76	2.82	9.25	2.89	9.48
13	2.08	6.82	2.12	6.96	2.16	7.09	2.20	7.22
12	1.65	5.42	1.69	5.55	1.78	5.84	1.81	5.94
11	1.32	4.33	1.35	4.43	1.37	4.49	1.40	4.59
10	1.040	3.420	1.063	3.380	1.120	3.680	1.140	3.740

5.1.3 The resistance of a copper conductor measured at a temperature other than 20 or 25°C is to be adjusted to the resistance at 20 or 25°C by means of the applicable multiplying factor from Adjustment factors for dc resistance of conductors in the Standard for Wire and Cable Test Methods, UL 2556.

5.1.4 Where measured as the means of size verification (see 5.1.2), the cross-sectional area of the conductor shall not be smaller than the minimum area indicated for the size in Table 5.1. The cross-sectional area of the conductor is to be determined as the sum of the areas of its component round strands, with the individual strands measured as described in 5.1.5.

5.1.5 The diameter of each individual strand is to be measured over the tin or other metal coating by means of a micrometer caliper having flat surfaces on both the anvil and the end of the spindle and calibrated to read directly to at least 0.001 inch or 0.01 mm. It is to be assumed that any one strand is practically constant in diameter throughout its length. Determination of the conductor size is to be in accordance with the Conductor diameter test in the Standard for Wire and Cable Test Methods, UL 2556.