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# Standard Specification for Wire for Use In Wire-Wound Resistors[1]

This standard is issued under the fixed designation B267; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers round wire and ribbon with controlled electrical properties for use in wire-wound resistance units and similar applications, but not for use as electrical heating elements.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

B63 Test Method for Resistivity of Metallically Conducting Resistance and Contact Materials

B77 Test Method for Thermoelectric Power of Electrical-Resistance Alloys

B84 Test Method for Temperature-Resistance Constants of Alloy Wires for Precision Resistors

## 3. Significance and Use

3.1 This specification on wire and ribbon contains the generic chemistry and requirements for resistivity, temperature coefficient of resistance, thermal emf versus copper resistance tolerances, and mechanical properties of bare wire, as well as the wire enamels and insulations of alloys normally used in the manufacture of wound resistors.

## 4. Alloy Classes

4.1 Fifteen classes of alloys are covered by this specification as listed in Table 1.

## 5. Elongation

5.1 The wire shall conform to the requirements for elongation as prescribed in Table 1, when tested on a 10-in. (254-mm) length.

## 6. Resistivity

6.1 The bare wire shall conform to the requirements for nominal resistivity as prescribed in Table 1.

6.2 Actual resistivity shall not vary from nominal resistivity by more than ±5 % for Alloy Classes 1 to 4 inclusive, and ±10 % for Alloy Classes 5 to 11 inclusive.

## 7. Nominal Electrical Resistance per Unit Length

7.1 The nominal resistance per unit length for round wire shall be calculated from the nominal resistivity and the nominal cross-sectional area.

NOTE 1—When ribbon or flat wire is produced by rolling from round wire, the cross section departs from that of a true rectangle by an amount depending on the width-to-thickness ratio and the specific manufacturing practice. The conventional formula for computing ohms per foot and feet per pound is to consider the cross section as 17 % less than a true rectangle when width is more than 15 times the thickness and 6 % less than a true rectangle in other cases. This is not valid in view of modern rolling equipment and practices, but still is widely used as a basis of description. Ribbon actually is made to a specified resistance per foot, and no tolerance is specified for thickness. An alternative and a closer approximation would be that for ribbon rolled round wire, the electrical resistance would be calculated on a cross 6 % less than a true rectangle.

## 8. Temperature Coefficient of Resistance

8.1 The change in resistance with change in temperature, expressed as the mean temperature coefficient of resistance based on the reference temperature of 25°C, shall be within the limits specified in Table 1, Columns 4 and 6, over the corresponding temperature ranges specified in Columns 5 and 7. The mean temperature coefficient of resistance referred to 25°C is defined as the slope of a chord of an arc. This slope is determined from the following equation:

$$\alpha_m = (\Delta R / R_{25} \Delta T) \times 10^6$$

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[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.10 on Thermostat Metals and Electrical Resistance Heating Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**TABLE 1 Classes of Alloys and Requirements**

| Alloy Class[A] | Alloy Composition, approximate, % | Resistivity, Ω·cmil/ft (μΩ·m) | Mean Temperature Coefficient of Resistance, $\alpha_m$ ppm for °C Over Temperature Range, Δ *T* | | | | Maximum Thermal emf versus Copper, m*V*/°C[B] | | Elongation in 10 in., min, % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Δ*T* | $\alpha_m$ | Δ*T* | m*V*/°C | Temperature Range, Δ *T*[C] | Over 0.002 in.[D] in Diameter | 0.002 to 0.001 in.[D] in Diameter | 0.0009 in.[D] in Diameter and Finer |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1a | nickel base, nonmagnetic | 800 (1.330) | 0, ±20 | +25 to −55 | 0, ±20 | +25 to +105 | +0.003 | −65 to +250 | 10 | 5 | 3 |
| 1b | nickel base, nonmagnetic | 800 (1.330) | 0, ±10 | +25 to −55 | 0, ±10 | +25 to +105 | +0.003 | −65 to +150 | 10 | 5 | 3 |
| 1c | nickel base, nonmagnetic | 800 (1.330) | 0, ±5 | +25 to −55 | 0, ±5 | +25 to +105 | +0.003 | −65 to +150 | 10 | 5 | 3 |
| 2a | iron base, magnetic | 800 (1.330) | 0, ±20 | +25 to −55 | 0, ±20 | +25 to +105 | −0.004 | −65 to +200 | 10 | 5 | 3 |
| 2b | iron base, magnetic | 800 (1.330) | 0, ±10 | +25 to −55 | 0, ±10 | +25 to +105 | −0.004 | −65 to +150 | 10 | 5 | 3 |
| 3a | 80 nickel, 20 chromium | 650 (1.081) | +80, ±20 | +25 to −55 | +80, ±20 | +25 to +105 | +0.006 | −65 to +250 | 15 | 5 | 3 |
| 3b | 80 nickel, 20 chromium, stabilized | 675 (1.122) | +60, ±20 | +25 to −55 | +60, ±20 | +25 to +105 | +0.006 | −65 to +250 | 15 | 5 | 3 |
| 4 | 60 nickel, 16 chromium, balance iron | 675 (1.122) | +140, ±30 | +25 to −55 | +140, ±30 | +25 to +105 | +0.002 | −65 to +200 | 15 | 5 | 3 |
| 5a | 55 copper, 45 nickel | 300 (0.499) | 0, ±20 | +25 to −55 | 0, ±20 | +25 to +105 | −0.045 | −65 to + 150 | 15 | 5 | 3 |
| 5b | 55 copper, 45 nickel | 300 (0.499) | 0, ±40 | +25 to −55 | 0, ±40 | +25 to +105 | −0.045 | −65 to +150 | 15 | 5 | 3 |
| 6 | manganin type | 290 (0.482) | 0, ±15[E] | [E] | 0, ±15[E] | [E] | −0.003 | +15 to +35 | 15 | 5 | 3 |
| 7 | 77 copper, 23 nickel | 180 (0.299) | +180, ±30 | +25 to −55 | +180, ±30 | +25 to +105 | −0.037 | −65 to +150 | 15 | 5 | 3 |
| 8 | 70 nickel, 30 iron | 125 (0.199) | +3600, ±400 | +25 to −50 | +4300, ±400 | +25 to +104 | −0.040 | −50 to +100 | 15 | 5 | 3 |
| 9 | 90 copper, 10 nickel | 90 (0.150) | +450, ±50 | +25 to −55 | +450, ±50 | +25 to +105 | −0.026 | −65 to +150 | 15 | 5 | 3 |
| 10 | 94 copper, 6 nickel | 60 (0.100) | +700, ±200 | +25 to −55 | +700, ±200 | +25 to +105 | −0.022 | −65 to +150 | 15 | 5 | 3 |
| 11 | 98 copper, 2 nickel | 30 (0.050) | +1400, ±300 | +25 to −55 | +1400, ±300 | +25 to +105 | 0.014 | −65 to +150 | 15 | 5 | 3 |

[A] Alloy Classes 1a to 8 inclusive are designed to provide controlled temperature coefficients. Values shown for other classes are for information only. All values are based on a reference temperature of 25°C.

[B] Alloy Classes 1a, 1b, 1c, 2a, 2b, 3a, 4, and 6 are designed to give a low emf versus copper. Values shown for other classes are for information only. Maximum indicates the maximum deviation from zero and the plus or minus sign the polarity of the couple.

[C] The maximum temperature values listed apply to the alloy wire only. Caution should be exercised pending knowledge of the maximum temperature of use for the coating material involved.

[D] If metric sizes are desired, 1 in. = 25.4 mm.

[E] Alloy Class 6 (manganin type for resistors), has a temperature-resistance curve of parabolic shape with the maximum resistance normally located between 25 and 30°C. Thus, Columns 5 and 7 cannot indicate 25°C as a limit but $\alpha^m$ may be expressed as a maximum of + 15 ppm for 15°C to the temperature of maximum resistance and a maximum of – 15 ppm from the temperature of maximum resistance to 35°C. All of the information included in this note is based on measurements made in accordance with Test Method B84.

where:

$\alpha_m$ = mean temperature coefficient of resistance, ppm/°C, Table 1, Columns 4 and 6,
$\Delta R$ = change in resistance over temperature range indicated in Table 1, Columns 5 and 7,
$R_{25}$ = resistance at 25°C,
$\Delta T$ = temperature range indicated in Table 1, Columns 5 and 7.

8.2 For Alloy Classes 1, 2, and 5, the temperature coefficient as specified in Table 1 of any 10-ft (3-m) length shall not vary more than 3 ppm/°C from that of any other 10-ft length on the same spool or coil.

## 9. Thermal EMF with Respect to Copper

9.1 The thermal electromotive force (emf) with respect to copper shall fall within the limits shown in Table 1, in the corresponding temperature ranges.

## 10. Permissible Variations in Electrical Resistance

10.1 The actual resistance per unit length of any wire furnished under these specifications shall not vary from the nominal resistance by more than the following amounts:

| Form | Permissible Variation, ±% |
|---|---|
| Over 0.005 in. (0.127 mm) in diameter | 5 |
| 0.002 to 0.005 in. (0.051 to 0.127 mm) in diameter, incl | 8 |
| Under 0.002 in (0.051 mm) in diameter | 10 |
| Ribbon | 5 |

10.2 For Alloy Classes 1 to 4 inclusive, the actual resistance of any 1-ft length of wire in one spool or coil shall not vary by more than 3 % from the actual resistance of any other 1 ft of wire in the same spool or coil.

10.3 For Alloy Classes 5 to 11 inclusive, the actual resistance of any 1-ft length of wire in one spool or coil shall not vary by more than 5 % from the actual resistance of any other 1 ft of wire in the same spool or coil.

## 11. Permissible Variations in Dimensions

11.1 Permissible variations in dimensions of bare wire are not specified, since these materials are used for resistance purposes, in which the resistivity and the electrical resistance per unit length, rather than the dimensions, are of prime importance. The electrical resistance per unit length can be determined more accurately than the dimensions of very small wire.

TABLE 2 Dimensions of Enamel Coated Wire [A]

| Nominal Bare Wire Size | | Light Coated Wire | | Medium Coated Wire | | Heavy Coated Wire | |
|---|---|---|---|---|---|---|---|
| B&S Gage No. | Diameter, in. | Outside Diameter, min, in. | Outside Diameter, max, in. | Outside Diameter, min, in. | Outside Diameter, max, in. | Outside Diameter, min, in. | Outside Diameter, max, in. |
| 28 | 0.0126 | 0.0130 | 0.0134 | 0.0134 | 0.0139 | 0.0139 | 0.0144 |
| 29 | 0.0113 | 0.0116 | 0.0120 | 0.0120 | 0.0125 | 0.0125 | 0.0130 |
| 30 | 0.010 | 0.0103 | 0.0107 | 0.0107 | 0.0112 | 0.0112 | 0.0116 |
| 31 | 0.0089 | 0.0092 | 0.0096 | 0.0096 | 0.0100 | 0.0100 | 0.0103 |
| 32 | 0.008 | 0.0083 | 0.0086 | 0.0086 | 0.0090 | 0.0090 | 0.0093 |
| 33 | 0.0071 | 0.0073 | 0.0076 | 0.0076 | 0.0080 | 0.0080 | 0.0083 |
| 34 | 0.0063 | 0.0064 | 0.0067 | 0.0067 | 0.0071 | 0.0071 | 0.0074 |
| 35 | 0.0056 | 0.0057 | 0.0060 | 0.0060 | 0.0064 | 0.0064 | 0.0067 |
| 36 | 0.005 | 0.0051 | 0.0054 | 0.0054 | 0.0057 | 0.0057 | 0.0060 |
| 37 | 0.0045 | 0.0046 | 0.0049 | 0.0049 | 0.0052 | 0.0052 | 0.0055 |
| 38 | 0.004 | 0.0041 | 0.0043 | 0.0043 | 0.0046 | 0.0046 | 0.0049 |
| 39 | 0.0035 | 0.0036 | 0.0038 | 0.0038 | 0.0041 | 0.0041 | 0.0043 |
| 40 | 0.0031 | 0.0032 | 0.0034 | 0.0034 | 0.0037 | 0.0037 | 0.0039 |
| | 0.00275 | 0.0029 | 0.0031 | 0.0031 | 0.0033 | 0.0033 | 0.0035 |
| | 0.0025 | 0.0026 | 0.0028 | 0.0028 | 0.0030 | 0.0030 | 0.0032 |
| | 0.00225 | 0.00235 | 0.0025 | 0.0025 | 0.0027 | 0.0027 | 0.0029 |
| | 0.002 | 0.0021 | 0.0022 | 0.0022 | 0.0024 | 0.0024 | 0.0026 |
| | 0.00175 | ... | 0.0019 | 0.0019 | 0.0021 | 0.0021 | 0.0023 |
| | 0.0015 | ... | 0.0016 | 0.0016 | 0.0018 | 0.0018 | 0.0020 |
| | 0.0014 | ... | 0.0015 | 0.0015 | 0.0017 | 0.0017 | 0.0019 |
| | 0.0013 | ... | 0.0014 | 0.0014 | 0.0016 | 0.0016 | 0.0018 |
| | 0.0012 | ... | 0.0013 | 0.0013 | 0.0015 | 0.0015 | 0.0017 |
| | 0.0011 | ... | 0.0012 | 0.0012 | 0.0014 | 0.0014 | 0.0016 |
| | 0.001 | ... | 0.0011 | 0.0011 | 0.0013 | 0.0013 | 0.0015 |
| | 0.0009 | ... | 0.0010 | 0.0010 | 0.0012 | 0.0012 | 0.0014 |
| | 0.0008 | ... | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0012 |
| | 0.0007 | ... | 0.0008 | 0.0008 | 0.0009 | 0.0009 | 0.0010 |
| | 0.0006 | ... | 0.0007 | 0.0007 | 0.0008 | 0.0008 | 0.0009 |
| | 0.0005 | ... | 0.0006 | 0.0006 | 0.0007 | 0.0007 | 0.0008 |

[A] To convert from inches to millimetres multiply by 25.4.

## 12. Finish

12.1 The wire shall be as uniform and free from kinks, curls, and surface defects such as seams, laminations, scale, and other irregularities as the best commercial practice will permit.

## 13. Enamel Coatings

13.1 Enamel coatings shall include any baked-on film of insulating material, such as varnish enamel, polyurethane, vinyl acetal, etc. and shall conform to the requirements prescribed in 13.2 to 13.7.

13.2 The physical dimensions of the enamel film shall conform to the requirements specified in Table 2.

13.3 The continuity of dielectric strength of medium or heavy enamel shall show a maximum of 10 breaks/100 ft. The test circuit shall have a recording sensitivity of 300 000 Ω ± 20 % with 150 V across the coating. The tension on the wire shall not exceed one half of its yield strength.

13.4 The coating shall have excellent adherence to the wire on which it is applied, allowing elongation until the wire breaks without rupture of the coating or loosening of its bond. The surface of the coating shall be smooth and uniform. The enamel shall not be underbaked so that one turn adheres to the next on a spool.

13.5 The recommended maximum temperature of use of wire coated with various materials shall be approximately as listed in Table 3.

TABLE 3 Recommended Maximum Temperatures

| Coating | Temperature, max,°C |
|---|---|
| Poly(vinyl formal)-phenolic | 105 |
| Poly(vinyl formal)-urethane | 105 |
| Polyurethane | 105 |
| Nylon | 105 |
| Epoxy | 105 |
| Terephthalate-polyester | 130 |
| Polyurethane-polyester | 155 |
| Modified silicones | 155 |
| Tetrafluorethylene | 180 |
| Polyester-imide | 180 |
| Polyimide | 220 |

13.6 The nominal temperatures specified in 13.5 do not restrict the use of materials at other temperatures when combined with insulation systems and proven by system test procedures.

13.7 Enameled wire shall withstand the following solubility test: Immerse a sample of the enameled wire in neutral mineral transformer oil for 48 h at 100°C, after which the enamel shall not be sufficiently softened so that it can be rubbed off with cheese cloth. The rubbing action shall be sufficiently slow so that the coating is not heated by friction. The test shall be made 2 to 10 min after removal of the wire from the oil, lightly wiping off the excess oil.

## 14. Insulated Coverings

14.1 Insulated coverings on wire shall include any wrapped textile covering such as cotton, silk, nylon, glass, etc. It shall include both single and double coverings. The second covering shall be wrapped in the opposite direction from the first.

14.2 The insulating covering shall be wrapped firmly, closely, evenly, and continuously around the wire. It shall be free from voids or bare spots and have a minimum of back twist. The covering shall be sufficiently closely wrapped so that, when the wire is bent around a mandrel having a diameter ten times the overall diameter of the covered wire, using only enough tension to give an even compact layer, the wrappings will not open enough to make the wire underneath visible to the unaided eye.

14.3 The nominal outside diameters (over insulation) shall be as shown in Table 4.

14.4 The recommended maximum temperatures of use of wire covered with various materials are shown in Table 5.

## 15. Test Methods

15.1 *Resistivity*—Test Method B63.

15.2 *Temperature Coefficient of Resistance*—The change in resistance with change in temperature shall be measured in accordance with Test Method B84.

15.3 *Thermal EMF*—The thermal emf with respect to copper shall be determined in accordance with Test Method B77.

**TABLE 4 Nominal Outside Diameters of Insulated Coverings** [A]

| Nominal Bare Wire Diameter, in. (mm) | Nominal Diameter Over Single Silk or Single Nylon, in. (mm) | Nominal Diameter Over Double Silk or Double Nylon in. (mm) | Nominal Diameter Over Single Cotton or Single Glass, in. (mm) | Nominal Diameter Over Double Cotton or Double Glass, in. (mm) |
|---|---|---|---|---|
| 0.0253 | 0.027 | 0.0288 | 0.0300 | 0.0338 |
| 0.0226 | 0.024 | 0.0261 | 0.0273 | 0.0311 |
| 0.0201 | 0.022 | 0.0236 | 0.0248 | 0.0286 |
| 0.0179 | 0.0197 | 0.0214 | 0.0224 | 0.0264 |
| 0.0159 | 0.0177 | 0.0194 | 0.0204 | 0.0244 |
| 0.0142 | 0.0160 | 0.0177 | 0.0187 | 0.0227 |
| 0.0126 | 0.0144 | 0.0161 | 0.0171 | 0.0211 |
| 0.0113 | 0.0131 | 0.0148 | 0.0158 | 0.0198 |
| 0.010 | 0.0118 | 0.0135 | 0.0145 | 0.0185 |
| 0.0089 | 0.0107 | 0.0124 | 0.0134 | 0.0174 |
| 0.008 | 0.0098 | 0.0115 | 0.0125 | 0.0165 |
| 0.0071 | 0.0089 | 0.0106 | 0.0116 | 0.0156 |
| 0.0063 | 0.0081 | 0.0098 | 0.0108 | 0.0148 |
| 0.0056 | 0.0074 | 0.0091 | 0.0101 | 0.0141 |
| 0.005 | 0.0068 | 0.0085 | 0.0090 | 0.0130 |
| 0.0045 | 0.0063 | 0.008 | 0.0085 | 0.0125 |
| 0.004 | 0.0058 | 0.0075 | 0.0080 | 0.0120 |
| 0.0035 | 0.0053 | 0.007 | 0.0075 | 0.0115 |
| 0.0031 | 0.0049 | 0.0066 | 0.0071 | 0.0111 |
| 0.00275 | 0.0043 | 0.0058 | ... | ... |
| 0.0025 | 0.0041 | 0.0055 | ... | ... |
| 0.00225 | 0.0038 | 0.0053 | ... | ... |
| 0.002 | 0.0036 | 0.005 | ... | ... |
| 0.00175 | 0.0033 | 0.0048 | ... | ... |
| 0.0015 | 0.003 | 0.0045 | ... | ... |
| 0.0014 | 0.003 | 0.0044 | ... | ... |
| 0.0013 | 0.0029 | 0.0043 | ... | ... |
| 0.0012 | 0.0028 | 0.0042 | ... | ... |
| 0.0011 | 0.0027 | 0.0041 | ... | ... |
| 0.001 | 0.0026 | 0.0040 | ... | ... |

[A] To convert from inches to millimetres multiply by 25.4.

**TABLE 5 Recommended Maximum Temperatures of Use for Covered Wire**

| Material | Temperature of Use, max, °C | |
|---|---|---|
| | Uncoated | Varnish Coated |
| Silk | 90 | 105 |
| Nylon | 90 | 105 |
| Cotton | 90 | 105 |
| Glass | 400 [A] | 220 (polyimide) |

[A] The purchaser should investigate the stability of the wire alloy under the temperature condition indicated.

**TABLE 6 Quantities of Wire and Capacities of Spools**

| Diameter of Wire, in. (mm) [A] | Weight per Spool, min, lb (kg) [B] | Capacity of Spool, lb (kg) [B] |
|---|---|---|
| 0.0005 | 0.004 | 1 |
| 0.0006 | 0.01 | 1 |
| 0.0007 | 0.015 | 1 |
| 0.0008 | 0.025 | 1 |
| 0.0009 | 0.035 | 1 |
| 0.001 | 0.04 | 1 |
| 0.0011 | 0.05 | 1 |
| 0.0012 | 0.06 | 1 |
| 0.0013 | 0.07 | 1 |
| 0.0014 | 0.08 | 1 |
| 0.0015 | 0.09 | 1 |
| 0.00175 to 0.00225 | 0.10 | 1 |
| 0.0025 to 0.0031 | 0.15 | 1 |
| 0.0035 to 0.0056 | 0.25 | 1 |
| 0.0063 to 0.010 | 0.50 | 2 |
| 0.0113 to 0.0226 | 2.50 | 5 |

[A] To convert from inches to millimetres multiply by 25.4.
[B] To convert from pounds to kilograms multiply by 0.453.

**TABLE 7 Types and Sizes of Spools**

| Capacity of Spool, lb (kg) [A] | Spool Dimensions, in. (mm) [B] | | | |
|---|---|---|---|---|
| | Diameter of Flange | Traverse | Diameter of Hole | Diameter of Barrel |
| 1 | 2½ | 3 | 0.635 | 1¼ to 1¾ |
| 2 | 3 | 3 | 0.635 | 1½ to 2 |
| 5 | 4 to 4½ | 3 | 0.635 | 1½ to 3 |

[A] To convert from pounds to kilograms multiply by 0.453.
[B] To convert from inches to millimetres multiply by 25.4.

## 16. Packaging

16.1 Bare, enameled, and insulated wire shall be supplied on spools and in quantities in accordance with Table 6. Ten percent of any order may be 75 % of the spool weight. Wire larger in diameter than sizes listed in Table 6 may be supplied on spools (Table 7) or in coils depending on agreement between the manufacturer and the purchaser. All alloys covered by these specifications are not available in all of the indicated sizes.

16.2 There shall be no splices or welds in coils or spools of wire.

16.3 All wire finer than 0.0035 in. (0.0889 mm) in diameter shall be shipped with each spool in an individual carton.

## 17. Marking

17.1 Coils or spools shall be tagged or marked to show the size, alloy class, resistance per foot, coating or insulation if any, and date.

17.2 The mean temperature coefficient of resistance from 25 to 150°C and 25 to −65°C shall be marked on the labels for Alloy Classes 1 and 2.

17.3 The alloy classes shall be identified with a tag or label of a specified color as follows:

| Alloy Class | Color |
|---|---|
| 1 | purple |
| 3 | yellow |
| 4 | red |
| 5 | pink |
| 6 | ivory |

## 18. Keywords

18.1 precision resistors; resistivity; resistor alloys; resistors; wire wound