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EIA STANDARD

Fixed Composition Resistors

RS-172-B
(Revision of RS-172-A)

MARCH 1975

Engineering Department

ELECTRONIC INDUSTRIES ASSOCIATION

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FIXED COMPOSITION RESISTORS

(From EIA Standard RS-172 and Standards Proposal No. 1164, formulated under the cognizance of EIA Working Group P-1.1 on Fixed Components)

1. SCOPE

1.1 This standard covers insulated, fixed resistors having a composition resistance element and capable of full load operation at an ambient temperature of 70°C. This standard describes minimum limits of performance commonly observed in commercially available products. There are products available with higher levels of performance for some characteristics.

1.2 CLASSIFICATION

1.2.1 Type Designation – The type designation shall be in the following form and as specified in 2.18:

1.2.1.1 Style – The style shall be identified by a three letter symbol "RRC" followed by a two-digit number; the letters identify insulated, composition, fixed resistors, and the number identifies the size and power rating of the resistor. See Table II.

1.2.1.2 Resistance – The nominal resistance value expressed in ohms shall be identified by a three-digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. When values less than 10 ohms are required, the letter "R" shall be substituted for one of the significant digits to represent the decimal point. When the letter "R" is used, the remaining two digits shall represent significant figures as shown in the following example:

2R7 = 2.7 ohms

The applicable standard resistance values for all styles shall be in accordance with the latest issues of EIA Standard RS-385.

1.2.1.3 Resistance Tolerance – The resistance tolerance shall be identified by a single letter in accordance with Table I.

TABLE I

RESISTANCE TOLERANCE

Symbol	Resistance Tolerance Percent ±
J	5
K	10
M	20

1.2.1.4 Illustration – The following tabulation illustrates the aforementioned type designation:

RRC20	153	M
Style	Resistance	Resistance Tolerance
1.2.1.1	1.2.1.2	1.2.1.3

2. REQUIREMENTS

2.1 DESIGN AND CONSTRUCTION – Resistors shall be of the design, construction and physical dimensions specified (see 2.18).

2.1.1 Body Color – The exterior body color of these resistors shall be any color except black, provided color code markings are legible (see 2.16).

2.1.2 Terminals – All terminals shall be suitably treated to facilitate soldering.

2.2 POWER RATING – Resistors shall have a power rating as specified (see 2.18) based on full load operation at an ambient temperature of 70°C. This power rating is dependent on the ability of resistors to meet the load life requirements specified in 2.12. Resistors operated at ambient temperatures in excess of 70°C shall be derated in accordance with Figure 1.

2.3 VOLTAGE RATING – Resistors shall have a rated dc continuous working voltage or an approximate sine wave rms continuous working voltage at commercial line frequency corresponding to the power rating as determined from the following formula:

$$E = \sqrt{PR}$$

where:

E = rated dc or rms continuous working voltage

P = power rating (2.2)

R = nominal resistance of resistor (see 1.2.1.2)

In no case shall the rated dc or rms continuous working voltage be greater than the applicable value shown in Table II.

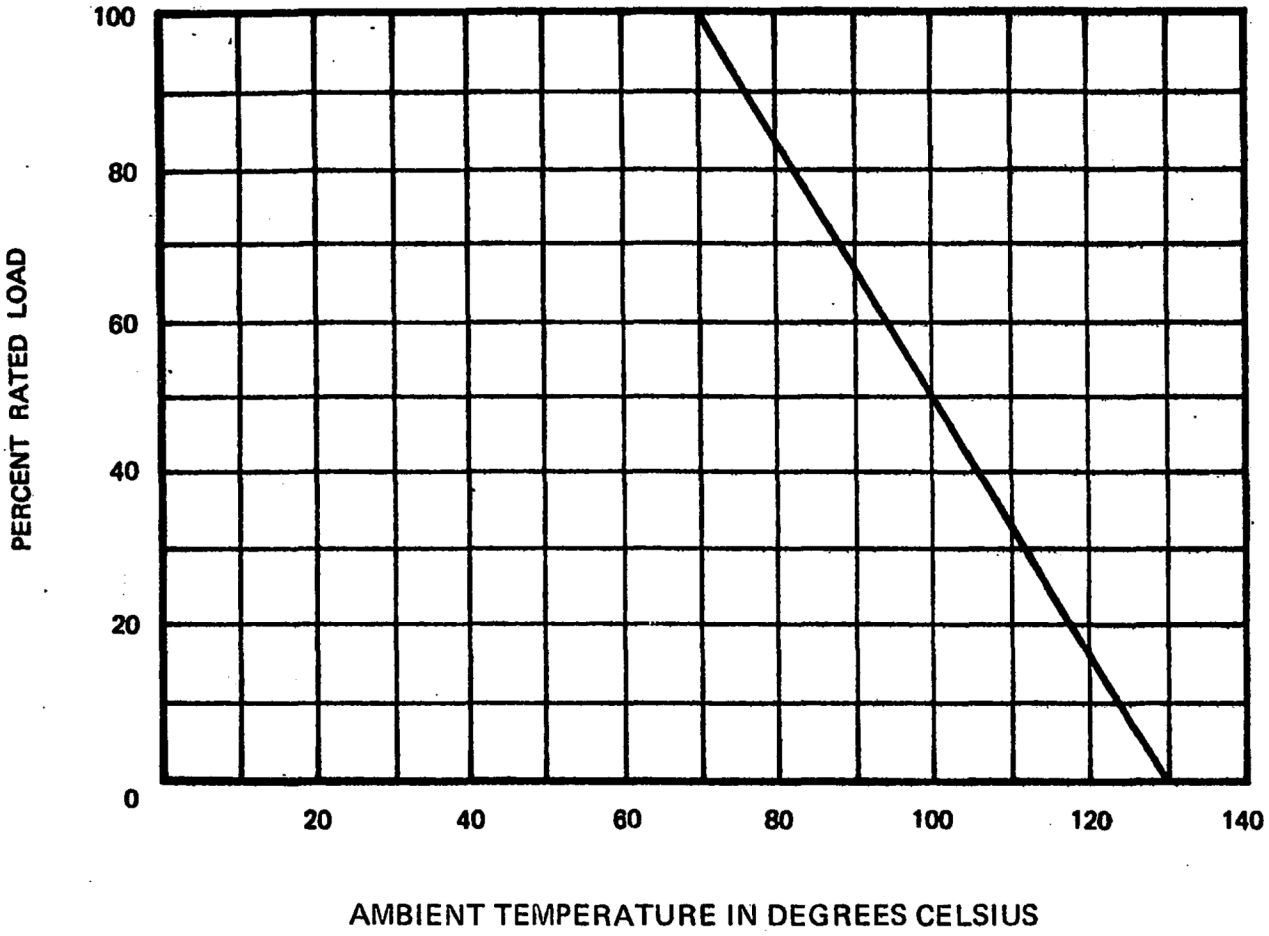


FIGURE 1

Derating for High Ambient Temperatures

TABLE II

MAXIMUM CONTINUOUS WORKING VOLTAGE

	Power Rating	Maximum Voltage (dc or rms)
Style	Watts	Volts
RRC05	1/8	150
RRC07	1/4	250
RRC20	1/2	350
RRC32	1	500
RRC42	2	500

2.4 RESISTANCE (see 1.2.1.3 and 3.2.2) – Resistors shall have a dc resistance within the specified tolerance of the nominal resistance.

2.5 RESISTANCE–TEMPERATURE CHARACTERISTIC (see 3.2.3) – The change in resistance at any temperature referred to an ambient temperature of 25°C shall not exceed the limits specified for the applicable temperatures and resistance values in Table III. The change in resistance at the intermediate temperatures shall not exceed a value proportional to the maximum values specified in Table III.

2.6 VOLTAGE COEFFICIENT (Applicable only to resistors of 1,000 ohms and over) – When resistors are tested as specified in 3.2.4, voltage-coefficient measurements which result in a total resistance change of 2 percent or less shall be considered satisfactory. However, if the change is greater than 2 percent, the voltage coefficient shall not exceed 0.05 percent per volt for resistors rated at 1/8 watt, 0.035 percent per volt for resistors rated at 1/4 watt and 1/2 watt, and 0.02 percent per volt for resistors rated above 1/2 watt.

2.7 DIELECTRIC WITHSTANDING VOLTAGE – When resistors are tested as specified in 3.2.5, there shall be no evidence of mechanical damage, arcing, or breakdown.

2.8 SHORT TIME OVERLOAD – When resistors are tested as specified in 3.2.6, there shall be no arc, burn, char or change in resistance in excess of ± (2.5% + 0.05 Ω).

2.9 LOW TEMPERATURE OPERATION – Resistors shall show no mechanical damage as a result of the tests specified in 3.2.7 nor shall the change in resistance between the initial and final measurement at 25°C ± 5°C exceed ± (3% + 0.05 Ω) for any individual resistor.

2.10 TEMPERATURE CYCLING – As a result of the test specified in 3.2.8, there shall be no mechanical damage nor shall the change in resistance of any resistor exceed a maximum of ± 4%.

TABLE III

RESISTANCE TEMPERATURE CHARACTERISTIC

Nominal Resistance	Maximum Allowable Change in Resistance From Resistance at Ambient Temperature of 25°C	
	At -55°C (Ambient)	At +105°C (Ambient)
Ohms	Percent ±	Percent ±
1,000 and under	6.5	5
1,100 to 10,000	10	6
11,000 to 100,000	13	7.5
Megohms		
0.11 to 1.0	15	10
1.1 to 10	20	15
11 and over	25	15

2.11 HUMIDITY – When tested as specified in 3.2.9, resistors shall show no damage. For each resistor the change from the initial to the final resistance shall not exceed ± 10%.

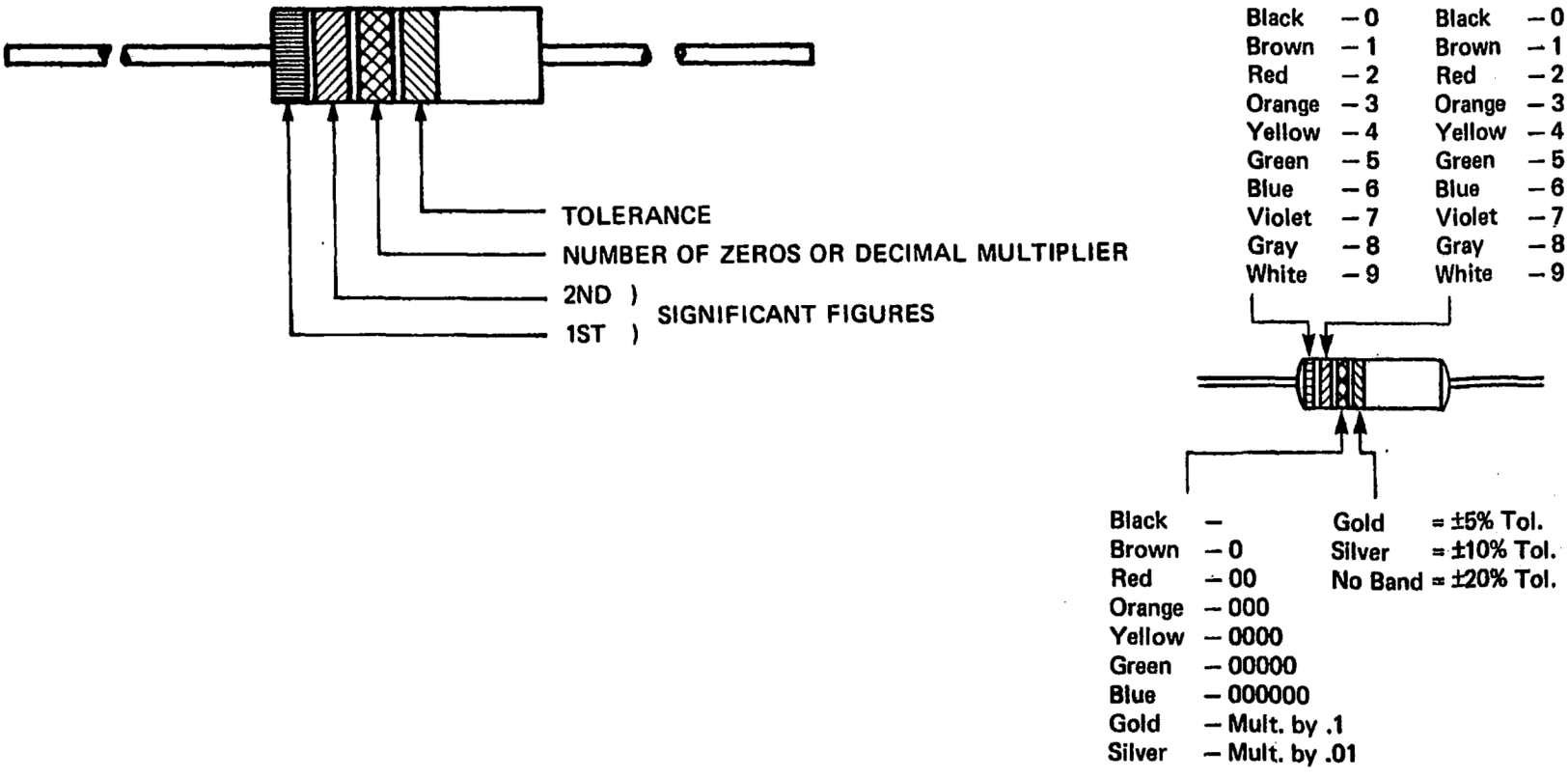
2.12 LOAD LIFE – When resistors are tested as specified in 3.2.10, the change in resistance between the initial resistance measurement and each of the succeeding measurements shall not exceed ± 10% for any individual resistor.

2.13 TERMINAL STRENGTH – When tested as specified in 3.2.11, there shall be no evidence of terminal breakage or mechanical damage to the resistor body and the resistance change shall not exceed ± (1% + 0.05 Ω).

2.14 RESISTANCE TO SOLDERING HEAT – As a result of the test specified in 3.2.12, there shall be no mechanical damage and the resistance shall not change in excess of ±(3% + 0.05 Ω).

2.15 SOLDERABILITY – Lead solderability shall be verified by conventional means and shall, as closely as possible, approximate the conditions of soldering employed by the user. The acceptable degree of solderability is negotiable between the user and the supplier. (Reference EIA Standard RS-178-A).

2.16 MARKING – Resistors shall be legibly and permanently marked with color coding. Colors shall be in accordance with the latest issue of EIA Standard RS-359. The marking shall remain legible at the end of all tests. Resistance value, decimal multiplier, if applicable, and resistance tolerance shall be indicated by color coding in accordance with Figure 2.



2.17 WORKMANSHIP – Resistors shall be manufactured and processed in a careful and workmanlike manner in accordance with good design and sound practice.

2.18 SPECIFICATION SHEETS FOR INDIVIDUAL RESISTOR STYLES – All requirements specified herein shall apply to all types of insulated, composition, fixed resistors covered by applicable specification sheets.

2.19 TEST GROUPINGS AND SEQUENCE – Test groupings and sequence in each test group shall be as indicated by Table IV.

TABLE IV

RECOMMENDED TEST GROUPINGS AND SEQUENCE

Group I

Visual and mechanical examination.
dc resistance.

Group II

Resistance-temperature characteristic.
Voltage coefficient (applicable only to resistors of 1000 ohms and over).
Dielectric withstanding voltage.
Short-time overload.

Group III

Low-temperature operation.
Temperature cycling.
Humidity.

Group IV

Life.

Group V

Terminal strength.
Resistance to soldering heat.

Group VI

Solderability.

3. STANDARD CONDITIONS AND TEST PROCEDURES

3.1 STANDARD TEST CONDITIONS AND METHODS

3.1.1 Temperature and Humidity – Unless otherwise specified herein, all measurements and tests shall be made at $25^{\circ} + 10^{\circ} -5^{\circ}$C at a barometric pressure of 28 to 32 inches of mercury and relative humidity not greater than 80%. However, measurements for referral purposes shall be made at 25°C ± 2°C and at a relative humidity of 20 to 50%.

3.1.2 Methods and Precautions – Adequate precaution shall be taken during tests to prevent condensation of moisture on resistors except during the low temperature operation, humidity and temperature cycling tests.

3.1.3 Conditioning – Prior to all tests, resistors shall be conditioned for 96 ± 4 hours at a temperature of $100^{\circ}C + 3^{\circ} -0^{\circ}$.* After conditioning, resistors shall be stored in desiccators using a suitable desiccant such as activated alumina or silica gel from the time of removal from the oven until the beginning of the test.

3.2 TEST PROCEDURES

3.2.1 Visual and Mechanical Inspection (see 2.1 to 2.1.2 inclusive and 2.16 to 2.18 inclusive) – Resistors shall be inspected to verify that the design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements.

3.2.2 Resistance (see 2.4) – The method employed for the measurement of resistance shall be such that for each measurement the combined inherent errors of the measuring instrument shall not exceed 0.5%. Measurements of resistance shall be made by using a dc potential applied for as short a time as practicable, but in no case for more than 5 seconds in order that the temperature of the resistance element will not rise appreciably during measurement. Table V gives the recommended test voltages impressed across the resistor in making resistance measurements. Other test voltages may be used; however, in no event shall the test voltage exceed the maximum shown in Table V. In the event that there is a conflict in results, attributable to the test voltages used, the nominal voltage specified in Table V shall be used to resolve the conflict. Unless otherwise specified, initial and subsequent measurements for a given test shall be made on the same instrument and at the same voltage.

3.2.3 Resistance–Temperature Characteristic (see 2.5) – The resistors shall be maintained at each of the ambient temperatures listed in Table VI. Resistance measurements shall be made at each temperature during a period from 30 to 45 minutes after resistors have attained that temperature. The temperature adjustment shall be accurate within 1°C. The percentage change in resistance, referred to a reference temperature of 25°C, shall be computed by the following formula:

* A less severe conditioning may be recommended by the resistor manufacturer.

$$\text{Percentage change in resistance} = \frac{\Delta R \times 100}{R_{25}}$$

where:

ΔR = change in resistance between 25°C and test temperature

R_{25} = resistance at reference temperature

Resistance values at temperature (b) and (c) shall be referred to resistance value at temperature (a), and resistance values at temperatures (e) and (f) shall be referred to resistance value at temperature (d).

3.2.4 Voltage Coefficient (applicable only to resistors of 1000 ohms and over - see 2.3 and 2.6) – Resistance shall be measured at 1/10 of rated continuous working voltage and at rated continuous working voltage. The voltage coefficient shall then be computed as follows:

$$\text{Voltage coefficient} = 100 \times \frac{(R_2 - R_1)}{R_1} \times \frac{1}{0.9E}$$

where:

E = rated continuous working voltage

R_1 = resistance at 0.1 rated continuous working voltage

R_2 = resistance at rated continuous working voltage

TABLE V

RECOMMENDED RESISTANCE TEST VOLTAGE

Resistance, Nominal Ohms	Test Potential Volts
2.7 to 91 Ω inclusive	.75 ± .25
100 to 910 Ω inclusive	2.75 ± .25
1,000 to 9,100 Ω inclusive	9.0 ± 1.0
10,000 to 91,000 Ω inclusive	27 ± 3
0.1 megohm or higher	90 ± 10

TABLE VI

AMBIENT TEMPERATURES FOR RESISTANCE TEMPERATURE CHARACTERISTIC

Sequence	Temperature °C
(a)	+ 25
(b)	- 15
(c)	- 55
(d)	+ 25
(e)	+ 65
(f)	+105

3.2.5 Dielectric Withstanding Voltage (see 2.7)

3.2.5.1 Mounting – The resistors shall be clamped in the trough of a 90° metallic V-block of such size that the body of the resistor does not extend beyond the extremeties of the block. The resistor leads shall be so positioned that the distance between the resistor leads and the V-block shall be not less than the radius of the resistor minus the radius of the lead wire.

3.2.5.2 Procedure – The rms voltage at commercial line frequency not exceeding 100 Hz specified in Table VII shall be applied to the resistors for 5 seconds between the resistor terminals connected together and the V-block at atmospheric pressure.

TABLE VII

DIELECTRIC WITHSTANDING VOLTAGE

Resistor Wattage	RMS Volts
1/8	300
1/4	500
1/2	700
1	1000
2	1000

3.2.6 Short Time Overload (see 2.8) – Following a measurement of resistance, a potential of 2.5 x the rated continuous working voltage (see 2.3) shall be applied for 5 seconds. In no case shall the voltage exceed the applicable value listed in Table VIII. Resistance shall be measured 30 minutes after removal of the test potential.

CAUTION: Test potential shall be established by use of a dummy load to avoid excess stress on the test specimens.

TABLE VIII

MAXIMUM OVERLOAD VOLTAGE

Power Rating Watts	Maximum Voltage (dc or peak ac) Volts
1/8	200
1/4	400
1/2	700
1	1000
2	1000

3.2.7 Low Temperature Operation (see 2.9) – Following the resistance measurement, resistors shall be placed in a cold chamber maintained at a temperature of $-65^{\circ}C + 0^{\circ}C - 5^{\circ}C$. After 1 hour of stabilization at this temperature, full rated working voltage, as specified in 2.3, shall be applied for 45 minutes. Resistors may be loaded individually or in parallel. 15 +5 –0 minutes after the removal of voltage, the specimens shall be removed from the chamber and maintained at a temperature of $25^{\circ}C \pm 5^{\circ}C$ for a period of 24 hours, after which resistance measurements shall again be made.

3.2.8 Temperature Cycling (see 2.10)

3.2.8.1 Mounting – Resistors shall be mounted by their terminals so that there shall be at least 1" of free air space around each resistor, and with the mounting in such a position with respect to the air stream that it offers substantially no obstruction to the flow of air across and around the resistors.

3.2.8.2 Procedure – Resistors shall be subjected to the temperature cycle shown in Table IX for a total of 5 cycles performed continuously. The air temperature shall be measured by a suitable means and as near the center of the group of resistors as possible. If a thermometer is used, it shall be mounted parallel to the axis of the resistor. The temperature shall be maintained at each of the extreme temperatures by means of circulating air. The hot and cold chamber shall be of such capacity that the air at the resistors will reach the temperature specified in Table IX within 2 minutes after the resistors have been transferred to the appropriate chamber. Resistors shall not be subjected to circulating air for the 10 to 15 minute periods at room temperature (25 ± 5°C). Measurements of resistance shall be made before the first cycle and within 24 hours after the fifth cycle.

TABLE IX

TEMPERATURE CYCLE

Sequence	Temperature °C	Time Minutes
Start at	+25 ±5	10 to 15
Reduce to	−55 +0, −3	30
Return to	+25 ±5	10 to 15
Raise to	+85, +3, −0	30
Return to	+25 ±5	10 to 15

3.2.9 Humidity (see 2.11) – Following measurement of resistance in a dry atmosphere of 25°C ± 5°C, resistors shall be placed in an atmosphere of 40°C ± 2°C and 90% to 100% relative humidity for 240 ± 8 hours. Resistors shall be removed at the end of this period, air dried for 1 hour ± 15 minutes, and final resistance measured.

3.2.10 Load Life (see 2.12)

3.2.10.1 Test Conditions – This test shall be conducted at an ambient temperature of 70°C ± 5°C. Resistors shall be mounted and soldered or clipped to terminals. The effective length of each lead shall be 1 "± 3/16 ". Resistors shall be so arranged that the temperature of any one resistor will not appreciably influence the temperature of any other resistor. There shall be no circulation of air directly over the resistors other than that caused by the heat of the resistors. The voltage used shall be the rated continuous working voltage specified in 2.3. Adequate precautions shall be taken to maintain constant voltage on resistors under test.

3.2.11 Terminal Strength (see 2.13)

3.2.11.1 Measurements – Resistance shall be measured before the testing specified in 3.2.11.2 and after the testing specified in 3.2.11.3.

3.2.11.2 Direct Load – Resistors shall be held by one terminal and the load shall be gradually applied in the direction of the longitudinal axis of the resistor until the applied load reaches 5 pounds for all styles except RRC05. Applied load shall be 2 pounds for style RRC05. The applied load shall be maintained for 5 seconds.

3.2.11.3 Twisting – Each wire lead shall be bent and twisted as specified in Figure 3.

3.2.12 Resistance To Soldering Heat (see 2.14) – Following a measurement of resistance, resistor terminals shall be immersed, one at a time, for 3 ± 1/2 seconds each in a pot of molten solder at a temperature of 350°C ± 5°C (250°C ± 5°C for style RRC05) to a point 1/8 to 3/16" from the resistor body. Resistance measurements shall be made 24 ± 4 hours after immersion.

4. PRECAUTIONARY NOTES

4.1 EXCESSIVE VOLTAGES – Application of the nominal rated continuous working voltage to a resistor having less than the nominal resistance because of a wide resistance tolerance will result in application of more than rated power with probable shortening of resistor life.

4.2 PEAK VOLTAGE – When nonsinusoidal peak voltages in excess of 1.4 times the rated sine wave continuous rms voltage are applied to the resistors, care should be taken to determine the suitability of resistors for use in such applications.

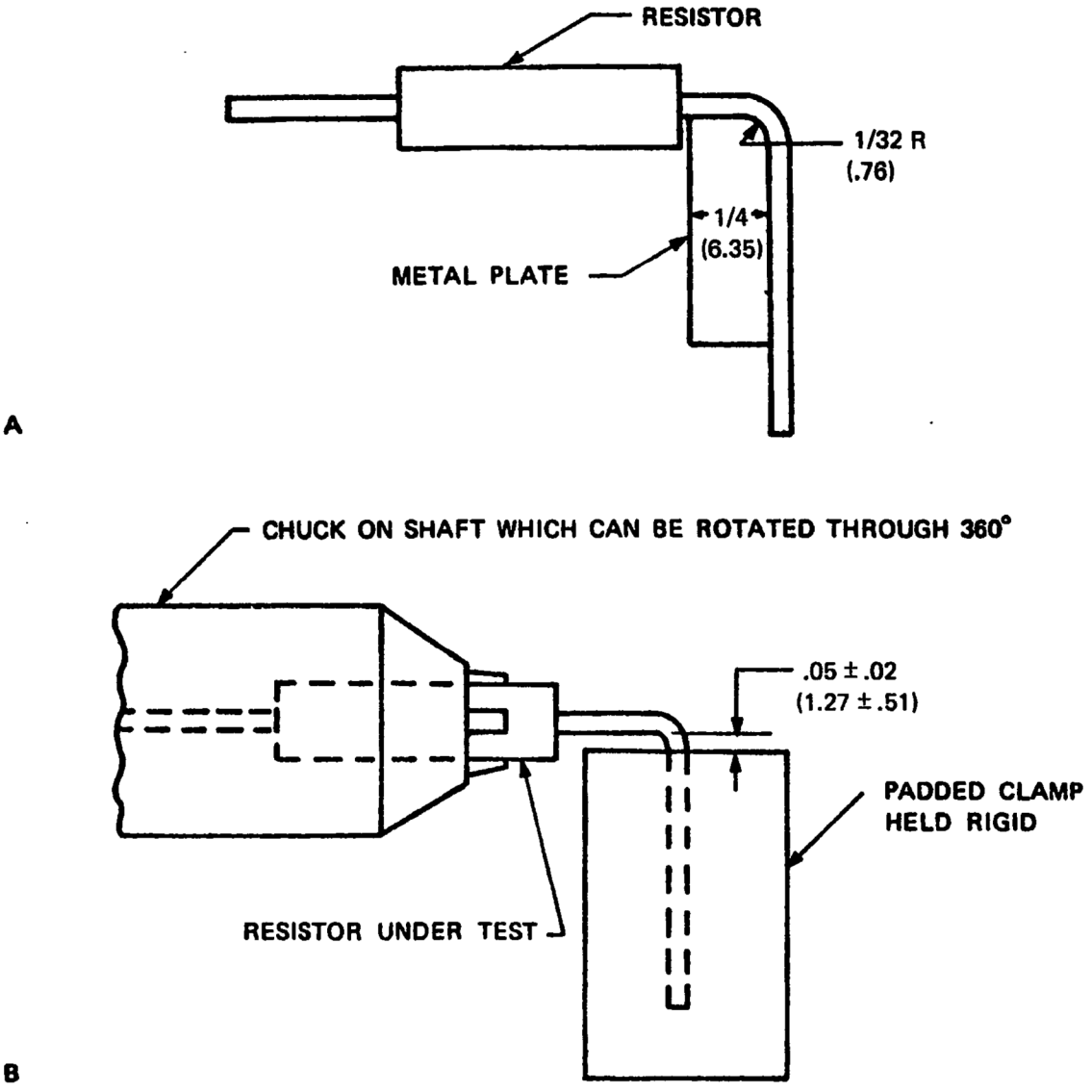
4.3 SOLDERING – Care should be taken in soldering resistors, since all properties of a composition resistor may be seriously affected when soldering irons are applied too close to a resistor body or for too long a period. The length of lead left between resistor body and soldering point should be not less than ¼ inch, nor should the required soldering time exceed 3 seconds.

4.4 HIGH ALTITUDE – All tests in this specification shall be performed at ambient atmospheric pressure. This fact should be considered when the use of these resistors for high-altitude conditions is contemplated.

4.5 STORAGE – Resistors may change in resistance value when stored for extended periods in uncontrolled temperature and humidity conditions.

FIGURE 3

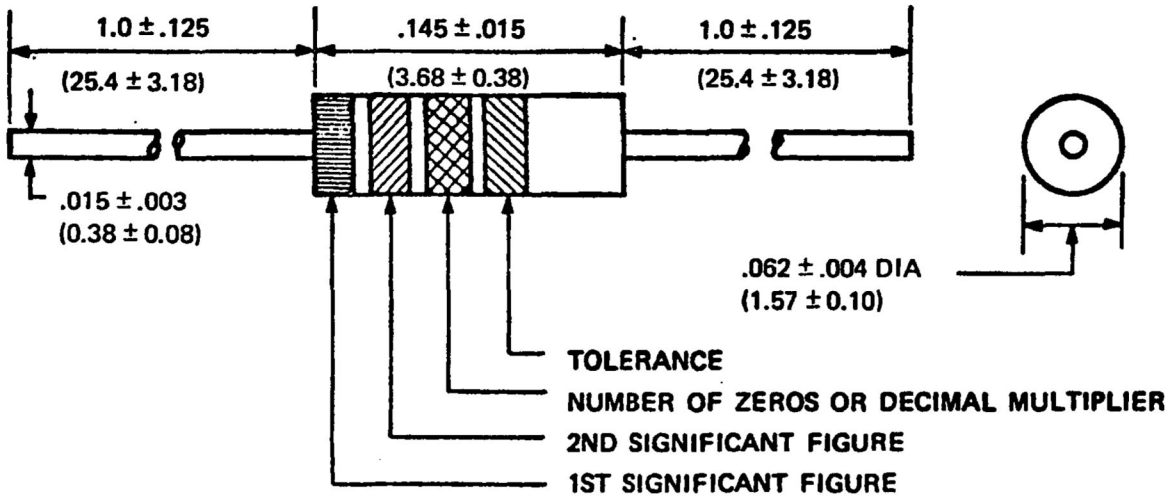
TWISTING TEST PROCEDURE



1. Bend lead with fingers over rounded edge of metal plate as shown in A.

2. Center resistor in chuck and secure lead in clamp as shown in B.

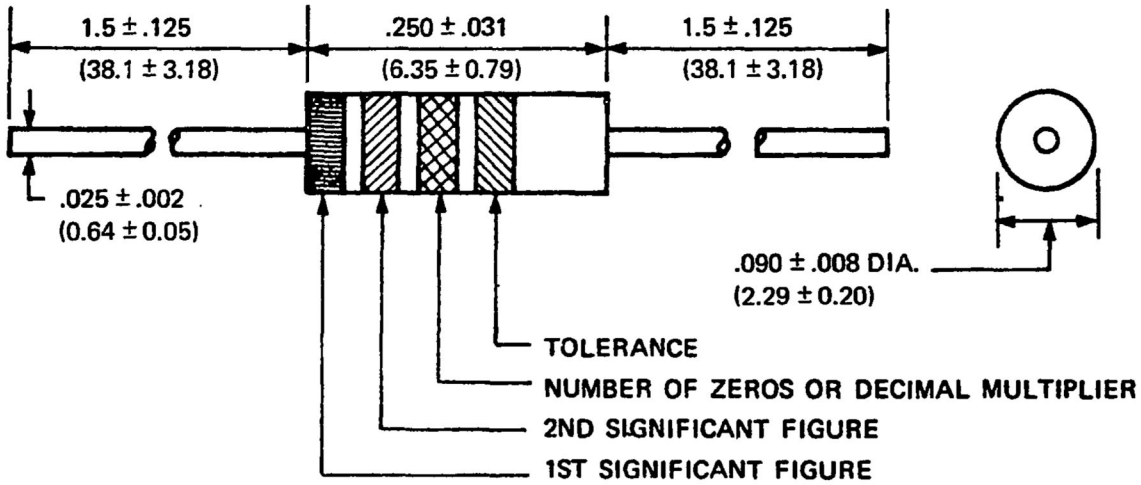
3. The chuck shall be rotated a total of three 360° rotations in alternating directions. Rotations shall be continuous through each 360° turn at a rate of two to five seconds per 360° rotation. During this test the chuck shall rotate around an axis which is fixed with respect to the padded clamp. The chuck shall have no appreciable end play during rotation.



NOTE 1: All dimensions in inches, with metric equivalents in parentheses

Minimum resistance	2.7 ohms
Maximum resistance	22 megohms
Power Rating	1/8 watt
Continuous working voltage (Maximum) (See paragraph 2.3)	150 volts

SPECIFICATION SHEET
Resistors, Fixed, Composition (Insulated), Style RRC05, 1/8 Watt

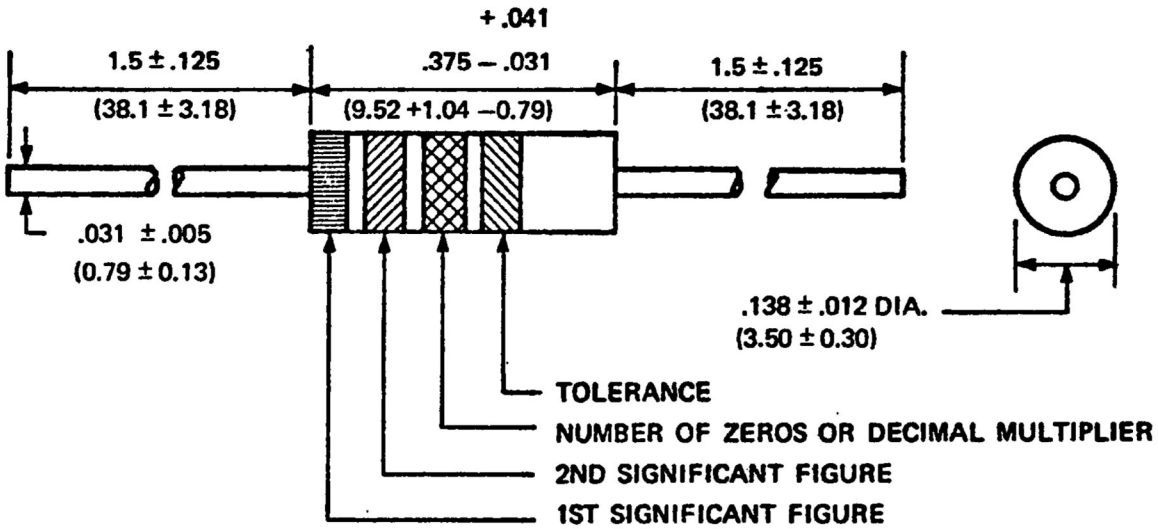


NOTE 1: All dimensions in inches, with metric equivalents in parentheses

Minimum resistance	2.7 ohms
Maximum resistance	22 megohms
Power rating	1/4 watt
Continuous working voltage (Maximum) (See paragraph 2.3)	250 volts

SPECIFICATION SHEET

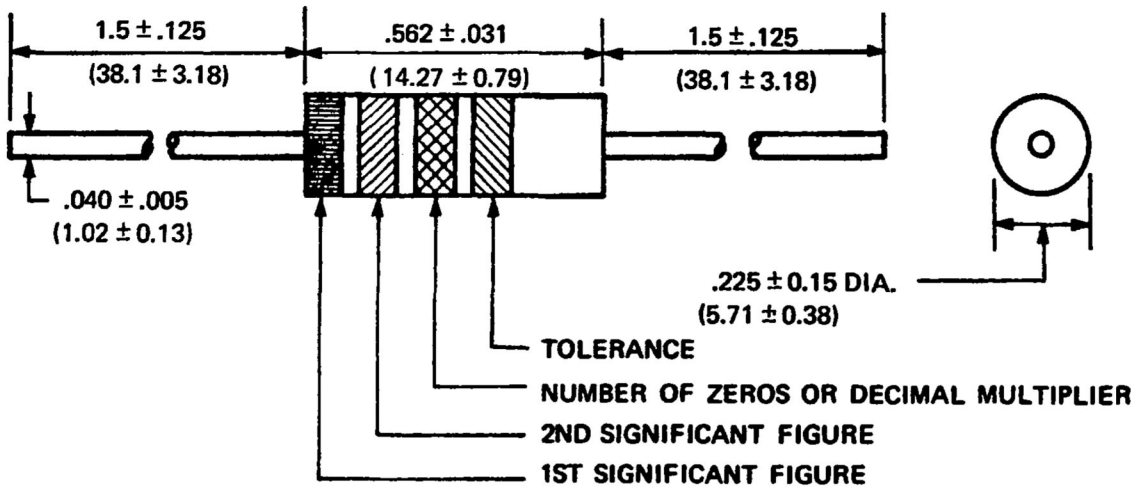
Resistors, Fixed, Composition (Insulated), Style RRC07, 1/4 Watt



NOTE 1: All dimensions in inches, with metric equivalents in parentheses

Minimum resistance	2.7 ohms
Maximum resistance	22 megohms
Power rating	1/2 watt
Continuous working voltage (Maximum) (See paragraph 2.3)	350 volts

SPECIFICATION SHEET
Resistors, Fixed, Composition (Insulated), Style RRC20, 1/2 Watt

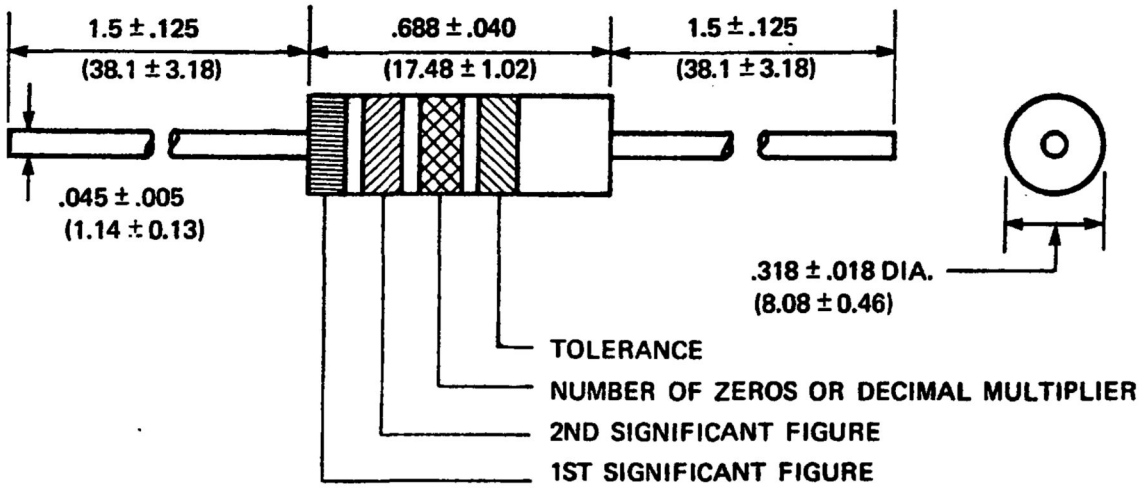


NOTE 1: All dimensions in inches, with metric equivalents in parentheses

Minimum resistance	2.7 ohms
Maximum resistance	22 megohms
Power rating	1 watt
Continuous working voltage (Maximum) (See paragraph 2.3)	500 volts

SPECIFICATION SHEET

Resistors, Fixed, Composition (Insulated), Style RRC32, 1 Watt



NOTE 1: All dimensions in inches, with metric equivalents in parentheses

Minimum resistance	10 ohms
Maximum resistance	22 megohms
Power Rating	2 watts
Continuous working voltage (maximum) (See paragraph 2.3)	500 volts

SPECIFICATION SHEET
Resistors, Fixed, Composition (Insulated), Style RRC42, 2 Watts

RELATED EIA STANDARDS

In addition to this Standard, the following EIA Standards are available on resistors:

RS-155-B	Fixed Wirewound Power Resistors	$3.60
RS-196-A	Fixed Film Resistors (High Stability)	$4.00
RS-229-A	Fixed, Wirewound, Precision Resistors	$3.30
RS-279	Color Code for Film Resistors	$1.00
RS-296-C	Reel Packaging of Axial Leaded Components	$1.20
RS-303	Variable Control Resistors (Adjustable Composition Resistance Units)	$3.00
RS-333	Wirewound Variable Resistors	$2.20
RS-344	Low Power, Insulated Fixed Wirewound Resistors	$3.30
RS-345	Resistors, Variable, Wirewound (Lead Screw Actuated)	$4.90
RS-360	Resistors, Variable (Lead-Screw Actuated) Non-Wirewound	$5.00
RS-391	Resistors, Variable, Wirewound, Precision	$10.00
RS-396	Resistors, Fixed Film Microelement	$ 4.50

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