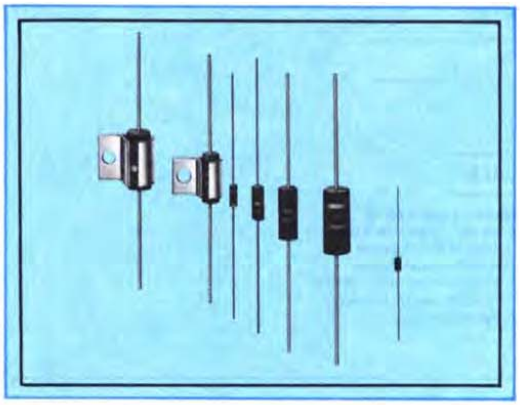
Types BB, CB, EB, GB, HB, GM, HM

Hot-Molded Fixed Resistors



1/8, 1/4, 1/2, 1, and 2 Watts (70° C)
1 Ohm to 1 Teraohm
± 5%, ± 10%, and ± 20% Tolerance

FEATURES

- Reliable
- Uniform Quality
- Predictable Performance
- Conservative Ratings
- Rugged Construction

Outstanding characteristics

Uniform quality — Consistent performance for over 35 years, no difference in quality regardless of value, rating or tolerance purchased: One grade — the finest.

Reliable — Recognized as the **most** reliable of all electronic components, Allen-Bradley hot-molded resistors provide freedom from catastrophic failure when used within ratings.

Predictable performance — Because of their outstanding uniformity, Allen-Bradley hot-molded resistors exhibit consistent responses to environment and loading.

Conservative ratings — All performance specifications are based on extensive testing and massive field experience.

Rugged construction — The solid, integral structure, combining leads, insulation, and resistance material in the exclusive Allen-Bradley hot-molding process provides exceptional strength and resistance to damage in automatic handling machinery.

Wide range of values — Available in standard preferred number values from 1 ohm to 100 megohms. Special values available on request.

High resistance values — Resistance values from 100 megohms to 1 million megohms (1 teraohm) are available on special order, in Types BB, CB, and EB.

Solderable/weldable leads — Hot solder coated leads remain easy to solder even after long periods in stock. The oxygen-free copper leads are readily weldable and allow considerable weld-schedule latitude. Stocking of resistors with two different lead materials is unnecessary.

Tracking — Allen-Bradley resistors exhibit extremely uniform tracking characteristics. For example, in flip-flop circuits, resistors used in pairs which are drawn from the same package or reel (a normal mass production practice) will track with each other throughout changes of temperature, humidity, and load. This assures reliable circuit performance throughout the design life of the equipment.

Durable color coding — Baked-on color code paints are resistant to solvents, and also resist the abrasion and chipping associated with automatic handling. They remain bright and easily readable even after long periods of use.

Temperature stable — Between 0° C and 85° C, Allen-Bradley hot-molded resistors exhibit a very low temperature characteristic, typically less than two percent deviation from room temperature values, less in low resistance values.

Outstanding features

All measurements made at room temperature except during Temperature Characteristics Test and Load Life Test.

For specific conditions such as mounting, test procedures, sequence of tests, etc., refer to Allen-Bradley Publication EC5021-2.2. Applicable test procedure numbers are listed in brackets [ ] below.

Characteristics		Hot-Molded Fixed Resistors				
		⅛ Watt Type BB	¼ Watt Type CB	½ Watt Type EB	1 Watt Type GB	2 Watt Type HB
Standard Resistance Range [1] Nominal EIA and MIL Values (See Page 20)		2.7 ohms to 100 megohms	2.7 ohms to 100 megohms	1.0 ohm to 100 megohms	1.0 ohm to 100 megohms	10 ohms to 100 megohms
Standard Tolerances		± 5%, ±10%, ± 20%	±5%, ± 10%, ± 20%	±5%, ±10%, ± 20%	± 5%, ±10%, ± 20%	± 5%, ± 10%, ± 20%
Power Rating Maximum continuous rated watts at 70° C ambient based on Load Life Test **[6.12]**		0.125 watt	0.25 watt	0.5 watt	1.0 watt	2.0 watts
Rated Continuous Working Voltage (RCWV) Based on nominal resistance (R) in ohms		$\sqrt{0.125 \times R}$ or 150 volts, whichever is less.	$\sqrt{0.25 \times R}$ or 250 volts, whichever is less.	$\sqrt{0.5 \times R}$ or 350 volts, whichever is less.	$\sqrt{1.0 \times R}$ or 500 volts, whichever is less.	$\sqrt{2.0 \times R}$ or 750 volts, whichever is less.
Maximum Ambient Temperature Power rating derated linearly to zero at this temperature		+ 130° C	+ 150° C	+ 150° C	+ 150° C	+ 150° C
Weight (Approximate)	Resistor with nominal length leads	0.077 gm	0.28 gm	0.61 gm	1.45 gm	2.80 gm
	Leads (per millimeter)	1,2 mg/mm	2,9 mg/mm	5,0 mg/mm	8,0 mg/mm	9,4 mg/mm

[1] MIL R-39008B Resistance Range
2.7 ohms to 22 megohms for ⅛, ¼, and 1 watt
1 ohm to 22 megohms for ½ watt
10 ohms to 22 megohms for 2 watts

Performance characteristics

Characteristics			Hot-Molded Fixed Resistors				
			⅛ Watt Type BB	¼ Watt Type CB	½ Watt Type EB	1 Watt Type GB	2 Watt Type HB
Insulation Resistance [6.6] Minimum			10,000 megohms	10,000 megohms	10,000 megohms	10,000 megohms	10,000 megohms
Dielectric Withstanding Voltage [6.5]	At Sea Level Atmospheric Press.		300 volts	500 volts	700 volts	1000 volts	1500 volts
	At 3.4" (86,36 mm) Hg (Simulated 50,000 ft. [15240 meters])		200 volts	325 volts	450 volts	625 volts	625 volts
Resistance-Voltage Coefficient [6.4] Maximum instantaneous change in resistance per volt based on ΔR for ΔV of (1.0—0.1) RCWV. **Nominal Resistance** (ohms)		10K	— 0.020%/volt	— 0.015%/volt	— 0.010%/volt	— 0.007%/volt	— 0.010%/volt
		100K	— 0.030	— 0.020	— 0.015	— 0.012	— 0.015
		1 Meg	— 0.045	— 0.025	— 0.020	— 0.015	— 0.020
		10 Meg	— 0.050	— 0.030	— 0.030	— 0.020	— 0.020
		22 Meg	— 0.050	— 0.035	— 0.035	— 0.020	— 0.020
		100 Meg	— 0.055	— 0.035	— 0.035	— 0.025	— 0.025
Load Life [6.12] 1000 hours operating at RCWV at 70° C ambient for duty cycle of 1½ hour "on", ½ hour "off". Permanent resistance change.		Maximum	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$
		Typical	— 3%	— 3%	— 3%	— 3%	— 3%
Load Life (temperature-derated) 1000 hours (1½ hour "on", ½ hour "off") at RCWV derated per temperature according to chart on Page 13. Tested at temperatures between 70° C and maximum ambient temperature. Permanent resistance change **[6.12** modified with respect to voltage applied, as described above.]		Maximum	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$	$+ 4\%$, $- 6\%$
		Typical	— 4%	— 4%	— 4%	— 4%	— 4%

Performance characteristics

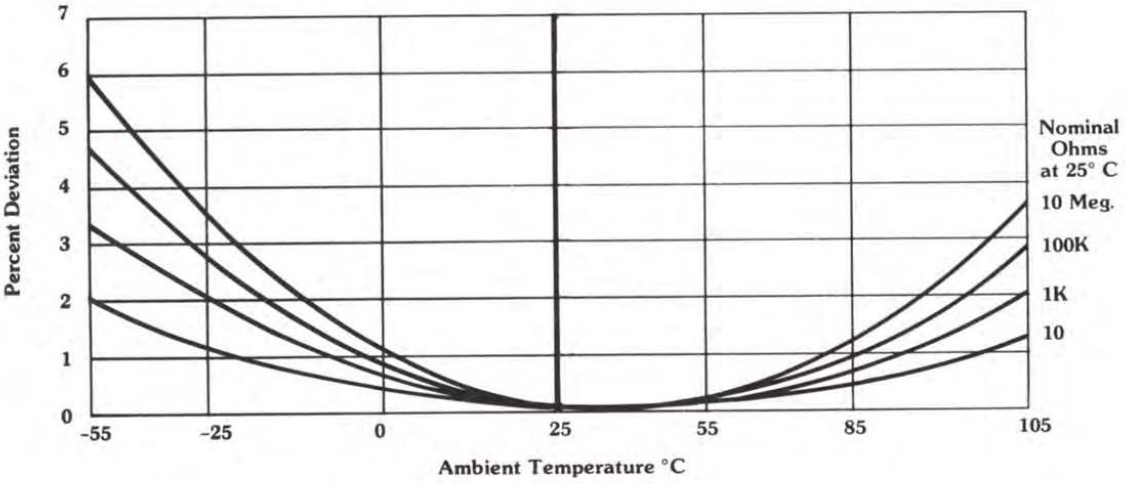
Characteristics			Hot-Molded Fixed Resistors				
			⅛ Watt Type BB	¼ Watt Type CB	½ Watt Type EB	1 Watt Type GB	2 Watt Type HB
Short-Time Overload [6.11] 5 seconds at 2½ times RCWV; voltage limit as stated. Maximum permanent resistance change.		Voltage Limits	200 volts	400 volts	700 volts	1000 volts	1000 volts
		Maximum	±(2.5% + 0.05 ohm)	±(2% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)
		Typical	+ 0.5%	+ 0.5%	+ 0.5%	+ 0.5%	+ 0.5%
Terminal Strength [6.13] 5 lb. (2,27 Kgm) Pull Test. Three turn Twist Test. Maximum permanent resistance change.			±(1% + 0.05 ohm) (2 lb. Pull Test) (0.91 Kgm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)
Effect of Solder Heat [6.14] Leads immersed to .125 in. (3,18 mm) of body in 350°C solder for 3 seconds. Maximum permanent resistance change.			±(2% + 0.05 ohm) (250°C Solder)	±(2% + 0.05 ohm)	±(3% + 0.05 ohm)	±(3% + 0.05 ohm)	±(3% + 0.05 ohm)
Vibration [6.17] 10-2000 Hz, 0.06 inch (1,52 mm) peak-to-peak or 20G, whichever is less.	Mechanical or Electrical Damage		No Damage	No Damage	No Damage	No Damage	No Damage
	Maximum Permanent Resistance Change		±(1% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)	±(1% + 0.05 ohm)
Shock [6.16] 100g, 6 ms, sawtooth, 10 shocks, 2 planes.	Mechanical or Electrical Damage		No Damage	No Damage	No Damage	No Damage	No Damage
	Maximum Permanent Resistance Change		±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)
Moisture Resistance [6.9] Temporary resistance change. See comment on Page 14.	Maximum		$+15_{-0}$%	$+12_{-0}$%	$+14_{-0}$%	$+8_{-0}$%	$+7_{-0}$%
	Typical		+ 9%	+ 6%	+ 7%	+ 5%	+ 4%
Humidity Characteristic (steady state) [6.10] 240 hours at + 40° C and 95% relative humidity. Temporary resistance change. **Nominal Resistance** (ohms)	10	Maximum	$+8_{-0}$%	$+5_{-0}$%	$+4_{-0}$%	$+3_{-0}$%	$+3_{-0}$%
		Typical	+ 4%	+ 3%	+ 2%	+ 2%	+ 1%
	1000	Maximum	$+9_{-0}$%	$+6_{-0}$%	$+6_{-0}$%	$+4_{-0}$%	$+4_{-0}$%
		Typical	+ 5%	+ 4%	+ 4%	+ 2%	+ 2%
	100K	Maximum	$+11_{-0}$%	$+9_{-0}$%	$+8_{-0}$%	$+5_{-0}$%	$+5_{-0}$%
		Typical	+ 8%	+ 6%	+ 6%	+ 3%	+ 2.5%
	10 Meg. and 100 Meg.	Maximum	$+13_{-0}$%	$+10_{-0}$%	$+9_{-0}$%	$+5_{-0}$%	$+5_{-0}$%
		Typical	+ 9%	+ 8%	+ 7%	+ 3%	+ 2.5%
Low Temperature Operation [6.7] After 1 hour at −65, + 0 −5° C, apply RCWV for 45 minutes. Remove RCWV, return to room temperature. Resistance change measured 24 hours after test.		Maximum	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)
		Typical	+ 0.5%	+ 0.5%	+ 0.5%	+ 0.5%	+ 0.5%
Temperature Cycling [6.8] Limits: −55° C and + 85° C. Resistance change after five cycles.		Maximum	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)	±(2% + 0.05 ohm)
		Typical	+ 0.5%	+ 0.5%	+ 0.5%	+ 0.5%	+ 0.5%

Temperature characteristics

In addition to the maximum values given in this table, typical curves of temporary resistance change due to temperature are illustrated at the top of the next page.

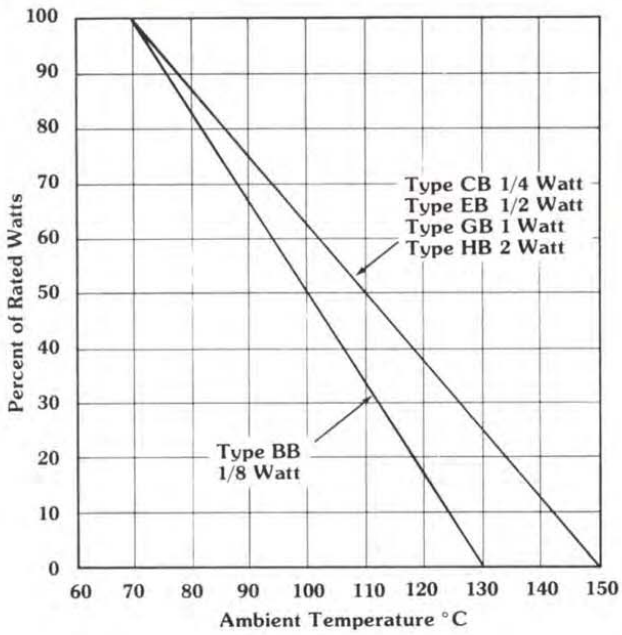
Resistance — Temperature Characteristic [6.3] Maximum temporary resistance change from the + 25° C initial resistance value. Note — Linear interpolation approximates intermediate values.	− 55° C	− 25° C	− 15° C	0° C	+ 25° C	+ 55° C	+ 65° C	+ 85° C	+ 105° C
	Range (%)	**Range (%)**	**Range (%)**	**Range (%)**	**Nominal Ohms**	**Range (%)**	**Range (%)**	**Range (%)**	**Range (%)**
	+0.2 to + 2.6	− 0.2 to + 1.3	− 0.2 to + 1.0	− 0.2 to + 0.6	1	− 0.4 to + 0.5	− 0.5 to + 0.7	− 0.5 to + 1.3	− 0.4 to + 2.0
	+0.2 to + 3.8	− 0.3 to + 2.0	− 0.3 to + 1.5	− 0.3 to + 0.9	10	− 0.6 to + 0.8	− 0.7 to + 1.1	− 0.8 to + 2.0	− 0.6 to + 3.0
	+0.3 to + 5.1	− 0.3 to + 2.7	− 0.4 to + 2.0	− 0.4 to + 1.1	100	− 0.8 to + 1.0	− 0.9 to + 1.5	− 1.0 to + 2.6	− 0.8 to + 4.0
	+0.3 to + 6.4	− 0.4 to + 3.4	− 0.5 to + 2.5	− 0.5 to + 1.4	1000	− 1.0 to + 1.3	− 1.2 to + 1.8	− 1.3 to + 3.3	− 1.0 to + 5.0
	+0.4 to + 7.7	− 0.5 to + 4.0	− 0.6 to + 3.0	− 0.6 to + 1.7	10K	− 1.2 to + 1.5	− 1.4 to + 2.2	− 1.5 to + 3.9	− 1.2 to + 6.0
	+0.5 to + 8.9	− 0.6 to + 4.7	− 0.7 to + 3.5	− 0.7 to + 2.0	100K	− 1.4 to + 1.8	− 1.6 to + 2.6	− 1.8 to + 4.6	− 1.4 to + 7.1
	+0.5 to + 10.2	− 0.7 to + 5.4	− 0.9 to + 4.0	− 0.8 to + 2.3	1 Meg	− 1.6 to + 2.0	− 1.9 to + 3.0	− 2.0 to + 5.2	− 1.6 to + 8.1
	+0.6 to + 11.5	− 0.8 to + 6.0	− 0.9 to + 4.5	− 0.9 to + 2.6	10 Meg	− 1.8 to + 2.3	− 2.1 to + 3.3	− 2.3 to + 5.9	− 1.8 to + 9.1
	+0.6 to + 11.9	− 0.8 to + 6.3	− 0.9 to + 4.7	− 0.9 to + 2.6	22 Meg	− 1.9 to + 2.4	− 2.2 to + 3.5	− 2.4 to + 6.1	− 1.9 to + 9.4
	+0.7 to + 12.8	− 0.8 to + 6.7	− 1.0 to + 5.0	− 0.9 to + 2.8	100 Meg	− 2.0 to + 2.5	− 2.4 to + 3.7	− 2.5 to + 6.6	− 2.0 to + 10.1

Typical resistance — temperature characteristics



Percent Resistance Deviation From 25° C Value for Various Nominal Resistance Values and Temperatures.

Derating with respect to ambient temperature



Derating — For resistors operated in ambient temperatures above 70° C, the change in resistance after 1000 hours under conditions similar to the Load Life Test will be less than + 4% to − 6% when the load wattage is derated in accordance with the curve shown. The most significant factor in proper derating to achieve minimal permanent resistance change over long periods of operation is the resultant surface temperature of the resistor. (See note 7 under Application Information.)

Resistor test voltages — In measuring resistance, it is important to take into account the effects of heating due to voltage application and the "offset" of resistance due to its voltage coefficient. Maximum voltage coefficients are listed on Page 11 of this publication. The voltage used should be applied for as short a time as possible, to minimize the effect of heating. For reference purposes, the voltages listed below should be used.

Nominal Resistance Range	Recommended Test Voltage (DC Volts)
1.0 to 9.1 ohms	0.3 volt
10 to 91 ohms	1.0 volt
100 to 910 ohms	3.0 volts
1000 to 9100 ohms	10 volts
10K to 91K ohms	30 volts
100K ohms and higher	100 volts

Moisture resistance testing — The results obtained from this test, defined in Publication EC5021-2.2 paragraph 6.9 which parallels MIL-STD-202 Method 106 have been found to vary because of the involved equipment required, the inclusion of several destructive-type procedures, and the poor reproduceability of the test. Isolation of the effects of moisture on resistors can be better achieved using the Steady State Humidity Test, paragraph 6.10 in Publication EC5021-2.2, paralleled by MIL-STD-202, Method 103. Maximum and typical values of resistance change for both tests are shown in the table on Page 12 of this publication.

Solderability — Allen-Bradley hot-molded fixed resistors meet the solderability requirements of MIL-R-39008 and MIL-STD-202, Method 208.

Resistance to solvents — The color code remains legible after resistors are subjected to the Resistance To Solvents test of MIL-STD-202, Method 215. Also, the resistors will withstand the Color Code Solvent Resistance test described in Paragraph 6.20 of Publication EC5021-2.2, which includes ultrasonically agitated liquids at elevated temperature.

Military qualification — The Allen-Bradley hot-molded fixed resistors meet or exceed all applicable military specifications including MIL-R-39008, Resistors, Fixed, Composition (Insulated), Established Reliability, and are fully qualified in all wattage sizes and all resistance values to the best reliability level, the "S" level, with a failure rate lower than 0.001% per 1000 hours.

Resistance measuring techniques — Measured resistance value is dependent upon the resistor temperature, the test voltage, and the degree of resistor dryness. Accurate correlation between repeated measurements, especially at different times, and different locations, requires that these three conditions be essentially the same.

Slight variations in resistor body temperature are not significant in room temperature measurements. However, the temperature of the resistor body may increase appreciably when tested at too high a voltage or when the voltage is applied for too long a time causing excessive heating.

The test voltage is very important and sometimes misunderstood or overlooked. This is because a tester is often unaware of the actual voltage that the instrument used is applying to the resistor under test. Commonly used instruments such as highly accurate resistance bridges or digital voltmeters employ relatively low voltages to make measurements, usually around 1 volt and seldom higher than 10 volts. This does not cause significant differences for low resistance values where the use of low test voltages is specified. However, for higher resistance values such as 100K ohms or higher, a test voltage of 90 or 100 volts is specified and use of a low voltage test instrument will result in a substantial difference in readings.

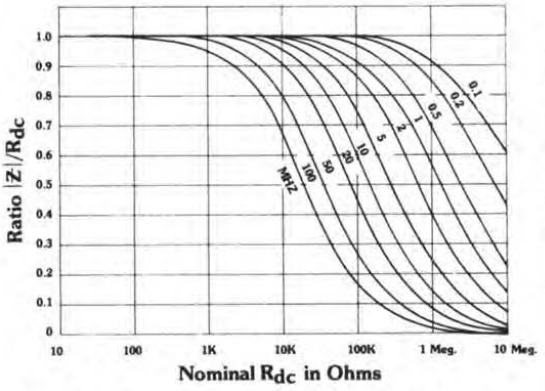
It is important to recognize that apparent out-of-tolerance on the + side can be caused by excessive moisture, and when such a condition is observed the test sample should then be conditioned in a dry oven as described in Publication EC5021-2.2.

Since both moisture and too low test voltages make the resistance value appear higher than when tested under standard conditions, it can be easily seen how these two effects when combined together may produce a significant measurement difference.

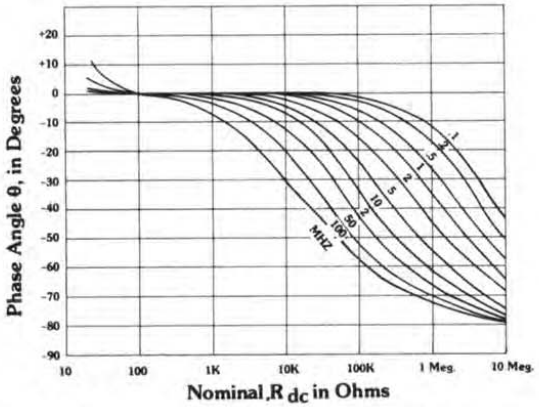
Other A-B hot-molded resistor publications — Resistor Test Procedures - Publication EC5021-2.2 covers resistor test procedures and contains a cross index of Allen-Bradley resistor test methods and the equivalent or near-equivalent methods specified in MIL-R-11, MIL-R-39008, MIL-STD-202 and EIA Specification RS-186.

Typical high frequency characteristics

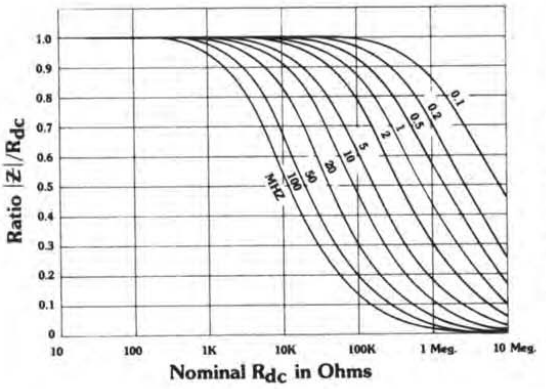
Measurement conditions — The curves below give typical values of impedance to DC resistance ratio and phase angle from 100 KHz to 100 MHz. Care was taken in test fixture design to prevent distributed capacitance to ground along the length of the resistor from contributing to measured values. Lead length was held at one quarter inch to standardize the lead inductance contribution. User's circuit variations from test conditions in mounting position and lead length can have a significant effect on the high frequency characteristics.



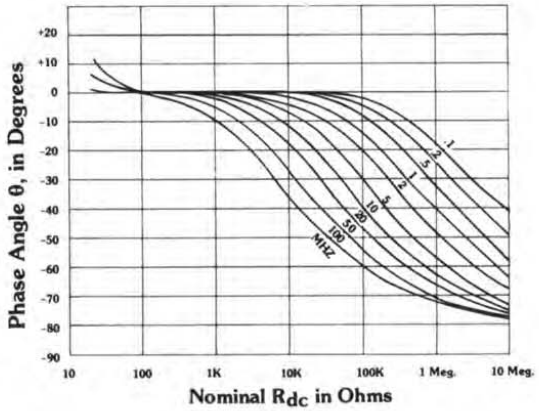
1/8 Watt Type BB 1/4 Watt Type CB



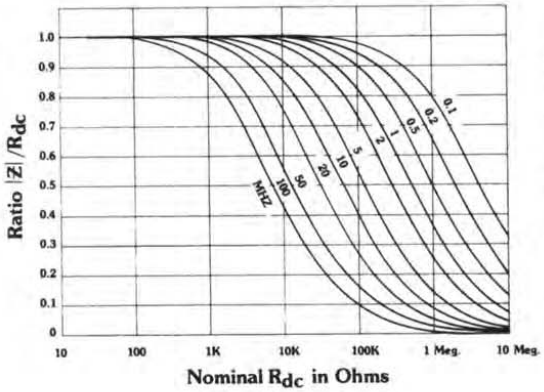
1/8 Watt Type BB 1/4 Watt Type CB



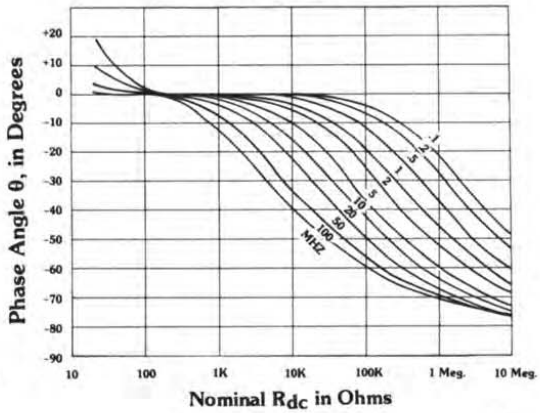
1/2 Watt Type EB



1/2 Watt Type EB

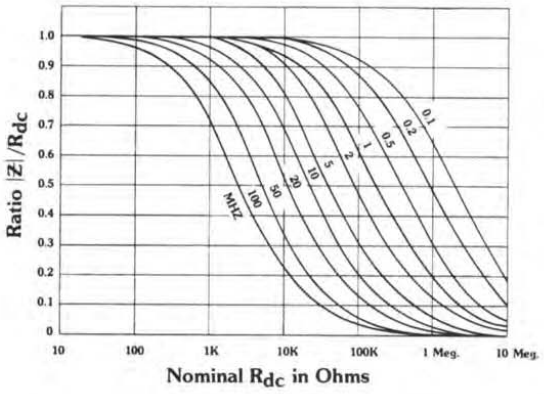


1 Watt Type GB

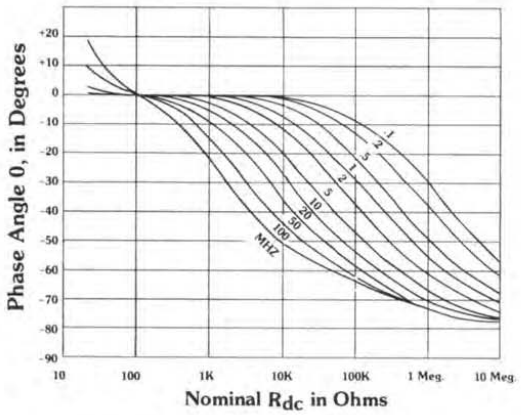


1 Watt Type GB

Typical high frequency characteristics



2 Watt Type HB



2 Watt Type HB

Metal clad fixed resistors

The Allen-Bradley Type GM and HM resistors are insulated Type GB and HB fixed composition resistors fitted with metal clamps which surround the major portion of the resistor. The metal clamps provide rigid mounting and efficient heat transfer from the resistors to the metal chassis or panels on which they are mounted.

It has been well established that Allen-Bradley fixed composition resistors exhibit superior reliability. When used according to published ratings and recommendations they do not open circuit nor exhibit large erratic changes of resistance value. The standard units are available up to and including 2 watt ratings.

Type GM and HM resistors make this same reliable performance AVAILABLE UP TO AND INCLUDING 5 WATTS.

Performance characteristics — The performance characteristics for Types GM and HM are the same as for Types GB and HB respectively, as shown in the tables on pages 11 and 12, with the following exceptions.

Nominal resistance range —
Type GM — 2.7 ohms to 22 megohms
Type HM — 10 ohms to 22 megohms

Standard tolerances — ± 5%, ± 10%

Power rating — When mounted on the equivalent of a steel panel 4 inches (101,60 mm) square and 0.05 inch (1,27 mm) thick

Type	70°C Ambient	40°C Ambient
GM	3 watts	4 watts
HM	4 watts	5 watts

Rated continuous working voltage (RCWV) —
Type GM $\sqrt{3.0 \times R}$ or 500 volts, whichever is less
Type HM $\sqrt{4.0 \times R}$ or 750 volts, whichever is less

Weight — Approximate, with nominal length leads
Type GM 4.7 gm
Type HM 8.0 gm

Insulation resistance — 100,000 megohms minimum between resistor leads and metal clamp

Dielectric withstanding voltage — At sea level, 1500 volts

Short time overload — ± (2.5% + 0.05 ohm), maximum

Capacitance — Between resistor leads and metal clamp
Type GM 5.6 pF, approximately
Type HM 9.0 pF, approximately

Reel packaged resistors

Reel packaged — Allen-Bradley hot-molded fixed resistors may be obtained reel packaged for use directly on automatic assembly equipment.

36-inch leader — A minimum of 36 inches (914,40 mm) of free tape are provided at each end of the reel for splicing purposes on lead tape reels. For body tape, a 12-inch (304,8 mm) leader at the core and a 36-inch (914,40 mm) leader on the outside end.

Heavy duty reel construction — The octagonal reels are made from corrugated fiberboard sides glued to a heavy fiberwound core. The reel is provided with metal bearings having a .562 inch (14,27 mm) hole.

Expendable — Since these reels are intended to be used as one-time dispensers of resistors, there are no storage problems, no returns.

Note: Long term storage of adhesive taped reel-packaged resistors is not recommended due to normal adhesive aging.

General requirements

1. Exposed adhesive of tape shall be less than 0.031 (0,79) in any area where it comes in contact with components or leads.
2. Standard reel packaging is with standard full length component leads. Lead trimming is available upon request for Types CB and EB, such that extension of lead ends beyond outside edges of lead tape is less than 0.031 (0,79).
3. A maximum of 0.25% of the components per reel quantity may be missing without consecutive missing components.
4. Cumulative pitch tolerance on "C" dimension shall not exceed 0.059 (1,5) over six consecutive components.

Tape spacing

A-B Type	Inside Tape Spacing D ± 0.062 (1,57)					
		Class I	Class II	Class III		
BB	1.812 (46,04)					
CB		2.062 ■ (52,39)	2.500 (63,5)	2.875 (73,03)	2.438 (61,93)	
EB		2.062 ■ (52,39)	2.500 (63,5)	2.875 (73,03)	2.438 (61,93)	
GB				2.875 ■ (73,03)	2.438 (61,93)	3.062 (77,27)
HB				2.875 ■ (73,03)	2.438 (61,93)	3.062 (77,77)

■ Standard

Note: Dimensions shown in parentheses are in millimeters.

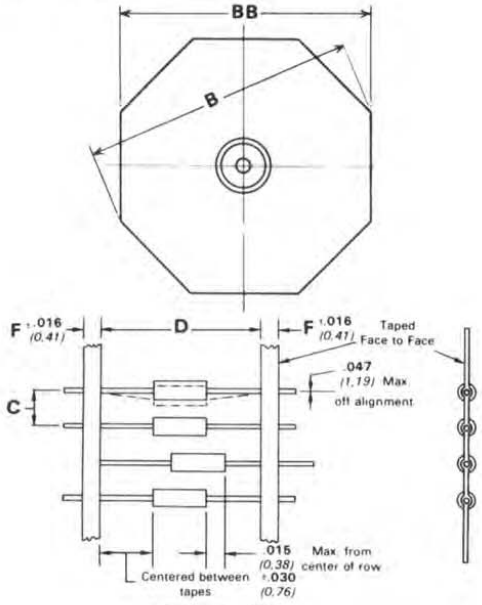
Reel packaging dimensions

	A-B Type	MIL-R-11 Style	MIL-R-39008 Style	Rating (Watts)	Standard Quantity (per reel)	Across Hubs A Max. Inches	Across Flanges AA Approx. Inches	Across Points B Max. Inches	Across Flats BB Max. Inches	Resistor Spacing C Inches	Between Hub Holes E Approx. Inches	Tape Width F Inches
Body Tape	BB	RC05	RCR05	1/8	1000 [1]	2.468 (62,69)	2.406 (61,11)	4.062 (103,17)	3.750 (95,25)	.076 max. (1,93)	1.593 (40,46)	.125 (3,18)
	BB	RC05	RCR05	1/8	4000 [1]	2.468 (62,69)	2.406 (61,11)	6.500 (165,10)	6.000 (152,40)	.076 max. (1,93)	1.593 (40,46)	.125 (3,18)
	CB	RC07	RCR07	1/4	2500 [1]	3.625 (92,08)	3.562 (90,47)	6.500 (165,10)	6.000 (152,40)	.120 max. (3,05)	2.750 (69,85)	.188 (4,78)
	EB	RC20	RCR20	1/2	2500	3.812 (96,82)	3.750 (95,25)	9.750 (247,65)	9.000 (228,60)	.170 max. (4,32)	2.938 (74,63)	2.50 (6,35)
	EB	RC20	RCR20	1/2	5000	3.812 (96,82)	3.750 (95,25)	13.188 (334,98)	12.188 (309,58)	.170 max. (4,32)	2.938 (74,63)	.250 (6,35)
	GB	RC32	RCR32	1	2000	4.062 (103,17)	4.000 (101,60)	13.188 (334,98)	12.188 (309,58)	.270 max. (6,86)	3.188 (80,98)	.375 (9,53)
	HB	RC42	RCR42	2	1000	4.062 (103,17)	4.000 (101,60)	13.188 (334,98)	12.188 (309,58)	.385 max. (9,78)	3.188 (80,98)	.375 (9,53)
Double Lead Tape	BB [2]	RC05	RCR05	1/8	500 [1]	2.688 (68,28)	2.625 (66,68)	4.062 (103,17)	3.750 (95,25)	.200 ± .015 (5,08 ± 0,38)	1.812 (46,02)	.250 (6,35)
	BB [2]	RC05	RCR05	1/8	2000 [1]	2.688 (68,28)	2.625 (66,68)	6.500 (165,10)	6.000 (152,40)	.200 ± 0.15 (5,08 ± 0,38)	1.812 (46,02)	.250 (6,35)
	CB	RC07	RCR07	1/4	2500 [1]	3.625 (92,08)	3.562 (90,47)	9.750 (247,65)	9.000 (228,60)	.200 ± .015 (5,08 ± 0,38)	2.750 (69,85)	.250 (6,35)
	CB	RC07	RCR07	1/4	5000 [1] [2]	3.625 (92,08)	3.562 (90,47)	13.188 (334,98)	12.188 (309,58)	.200 ± .015 (5,08 ± 0,38)	2.750 (69,85)	.250 (6,35)
	EB	RC20	RCR20	1/2	2500	3.812 (96,82)	3.750 (95,25)	9.750 (247,65)	9.000 (228,60)	.200 ± .015 (5,08 ± 0,38)	2.938 (74,63)	.250 (6,35)
	EB	RC20	RCR20	1/2	5000 [2]	3.812 (96,82)	3.750 (95,25)	13.188 (334,98)	12.188 (309,58)	.200 ± .015 (5,08 ± 0,38)	2.938 (74,63)	.250 (6,35)
	GB	RC32	RCR32	1	2000	4.062 (103,17)	4.000 (101,60)	13.188 (334,98)	12.188 (309,58)	.375 ± .015 (9,53 ± 0,38)	3.188 (80,98)	.250 (6,35)
	HB	RC42	RCR42	2	1000	4.062 (103,17)	4.000 (101,60)	13.188 (334,98)	12.188 (309,58)	.375 ± .015 (9,53 ± 0,38)	3.188 (80,98)	.250 (6,35)

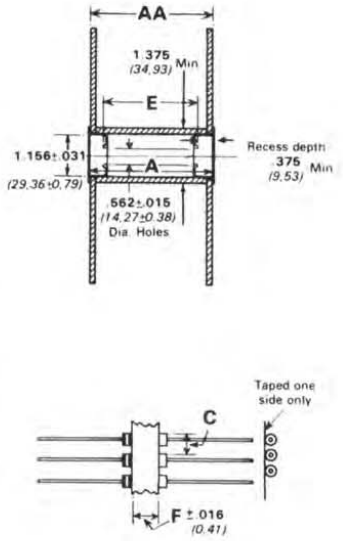
[1] Kraft paper is wound between layers of Types BB and CB for full length of reel. For Types EB, GB, and HB it is wound only as far as necessary for adequate protection.

[2] Available upon request.

Note: Dimensions shown in parentheses are in millimeters.



LEAD TAPE



BODY TAPE

Application information

The following information has been compiled to aid in the everyday selection and application of Allen-Bradley hot-molded resistors. The statements on this page should be helpful in evaluating the use of all types of A-B hot-molded resistors in broad general terms, and are not to be interpreted as precise. A comprehensive list is made of the standard nominal resistance values in their available tolerance categories, the rated continuous working voltages for all hot-molded types, the part numbers, and color codes — all information provided for all values from 1 ohm to 100 megohms, taking into account the available range of values for each type as of the date of this publication.

1. Low-value resistors exhibit less change due to humidity, temperature and voltage than high-value resistors.
2. Resistance changes due to increase in moisture content are always positive.
3. Resistance changes due to humidity are temporary, and, in the case of Allen-Bradley resistors, are reversible.
4. Change of resistance which has occurred due to humidity may be essentially eliminated by conditioning the resistor at 100°C or by dry storage.
5. The effects of humidity may be minimized by operating the resistor with as little as 1/10 rated wattage load.
6. Resistance change due to load life is permanent and usually ultimately negative.
7. Resistance change due to load life can be minimized — 1% to 2% in many thousands of hours by 50% derating. This same result can be attained by limiting the maximum operating surface temperature of the resistor under load to 100°C. Permanent resistance changes as the result of storage at temperatures below 100°C are negligible, even for extended time periods.
8. Resistance change due to soldering is positive and may be permanent if the resistor has excessive moisture present in its body. It can be greatly minimized if resistors are dry at the time of soldering.
9. The temperature characteristic of Allen-Bradley resistors is positive above +80° and below −10°C.
10. The temperature characteristic of the Allen-Bradley resistor is negligible from −10°C to +80°C.
11. The voltage characteristic (negative) and the temperature characteristic (positive) tend to cancel one another in an Allen-Bradley resistor under average operating conditions, where both significant voltage and elevated temperature are present.
12. The heat sink to which a resistor is connected affects its rating. Resistors operated in multiple should be derated unless adequate heat sinks are provided.
13. The quality and reliability of Allen-Bradley resistors is the same for, and independent of, any resistance tolerances shown on the resistor.
14. Years of accumulated experience have shown that Allen-Bradley hot-molded resistors are unequalled for uniformity, predictable performance, appearance, and freedom from catastrophic failure. Allen-Bradley resistors are made by an exclusive hot-molding process on automatic machines — developed, built, and used only by Allen-Bradley. There is such complete uniformity from one resistor to the next — million after million — that long term in-circuit performance can be predicted with usable accuracy. When used according to published ratings and recommendations, Allen-Bradley hot-molded fixed resistors will not open circuit nor exhibit erratic changes of resistance value. They are probably the most reliable of all electronic components.

Standard resistance values

Nominal Resistance in Ohms — TOLERANCE COLOR CODE (4th BAND)			Rated Continuous Working Voltage (RCWV) DC or RMS Volts — WATTAGE and TYPE									Resistor Part Number			Resistance Color Code		
												Type		Tolerance	1st BAND	2nd BAND	3rd BAND
			⅛ [1]	¼ [2]	½ [2]	1 [2]	2 [2]	3 [2]	4 [3]	4 [2]	5 [3]	BB CB EB GB etc.	Value Code	5 = 5% 1 = 10% 2 = 20%	1st digit	2nd digit	Number of zeros after 1st and 2nd digit
Gold ±5%	Silver ±10%	None ±20%	BB	CB	EB	GB	HB	GM	GM	HM	HM	XX	000	X			
1.0	1.0	1.0	—	—	0.707	1.00	—	—	—	—	—		10G		Brown	Black	Gold
1.1	—	—	—	—	0.742	1.05	—	—	—	—	—		11G		Brown	Brown	Gold
1.2	1.2	—	—	—	0.775	1.10	—	—	—	—	—		12G		Brown	Red	Gold
1.3	—	—	—	—	0.806	1.14	—	—	—	—	—		13G		Brown	Orange	Gold
1.5	1.5	1.5	—	—	0.866	1.22	—	—	—	—	—		15G		Brown	Green	Gold
1.6	—	—	—	—	0.894	1.26	—	—	—	—	—		16G		Brown	Blue	Gold
1.8	1.8	—	—	—	0.949	1.34	—	—	—	—	—		18G		Brown	Gray	Gold
2.0	—	—	—	—	1.00	1.41	—	—	—	—	—		20G		Red	Black	Gold
2.2	2.2	2.2	—	—	1.05	1.48	—	—	—	—	—		22G		Red	Red	Gold
2.4	—	—	—	—	1.10	1.55	—	—	—	—	—		24G		Red	Yellow	Gold
2.7	2.7	—	0.581	0.822	1.16	1.64	—	2.85	3.29	—	—		27G		Red	Violet	Gold
3.0	—	—	0.612	0.866	1.22	1.73	—	3.00	3.46	—	—		30G		Orange	Black	Gold
3.3	3.3	3.3	0.642	0.908	1.28	1.82	—	3.15	3.63	—	—		33G		Orange	Orange	Gold
3.6	—	—	0.671	0.949	1.34	1.90	—	3.29	3.79	—	—		36G		Orange	Blue	Gold
3.9	3.9	—	0.698	0.987	1.40	1.97	—	3.42	3.95	—	—		39G		Orange	White	Gold
4.3	—	—	0.733	1.04	1.47	2.07	—	3.59	4.15	—	—		43G		Yellow	Orange	Gold
4.7	4.7	4.7	0.766	1.08	1.53	2.17	—	3.76	4.34	—	—		47G		Yellow	Violet	Gold
5.1	—	—	0.798	1.13	1.60	2.26	—	3.91	4.52	—	—		51G		Green	Brown	Gold
5.6	5.6	—	0.837	1.18	1.67	2.37	—	4.10	4.73	—	—		56G		Green	Blue	Gold
6.2	—	—	0.880	1.24	1.76	2.49	—	4.31	4.98	—	—		62G		Blue	Red	Gold
6.8	6.8	6.8	0.922	1.30	1.84	2.61	—	4.52	5.22	—	—		68G		Blue	Gray	Gold
7.5	—	—	0.968	1.37	1.94	2.74	—	4.74	5.48	—	—		75G		Violet	Green	Gold
8.2	8.2	—	1.01	1.43	2.02	2.86	—	4.96	5.73	—	—		82G		Gray	Red	Gold
9.1	—	—	1.07	1.51	2.13	3.02	—	5.22	6.03	—	—		91G		White	Brown	Gold
10	10	10	1.12	1.58	2.24	3.16	4.47	5.48	6.32	6.32	7.07		100		Brown	Black	Black
11	—	—	1.17	1.66	2.34	3.32	4.69	5.74	6.63	6.63	7.42		110		Brown	Brown	Black
12	12	—	1.22	1.73	2.45	3.46	4.90	6.00	6.93	6.93	7.75		120		Brown	Red	Black
13	—	—	1.28	1.80	2.55	3.61	5.10	6.24	7.21	7.21	8.06		130		Brown	Orange	Black
15	15	15	1.37	1.94	2.74	3.87	5.48	6.71	7.75	7.75	8.66		150		Brown	Green	Black
16	—	—	1.41	2.00	2.83	4.00	5.66	6.93	8.00	8.00	8.94		160		Brown	Blue	Black
18	18	—	1.50	2.12	3.00	4.24	6.00	7.35	8.48	8.48	9.49		180		Brown	Gray	Black
20	—	—	1.58	2.24	3.16	4.47	6.32	7.75	8.94	8.94	10.0		200		Red	Black	Black
22	22	22	1.66	2.34	3.32	4.69	6.63	8.12	9.38	9.38	10.5		220		Red	Red	Black
24	—	—	1.73	2.45	3.46	4.90	6.93	8.48	9.80	9.80	11.0		240		Red	Yellow	Black
27	27	—	1.84	2.60	3.67	5.20	7.35	9.00	10.4	10.4	11.6		270		Red	Violet	Black
30	—	—	1.94	2.74	3.87	5.48	7.75	9.49	11.0	11.0	12.2		300		Orange	Black	Black
33	33	33	2.03	2.87	4.06	5.74	8.12	9.95	11.5	11.5	12.8		330		Orange	Orange	Black
36	—	—	2.12	3.00	4.24	6.00	8.48	10.4	12.0	12.0	13.4		360		Orange	Blue	Black
39	39	—	2.21	3.12	4.42	6.24	8.83	10.8	12.5	12.5	14.0		390		Orange	White	Black
43	—	—	2.32	3.28	4.64	6.56	9.27	11.4	13.1	13.1	14.7		430		Yellow	Orange	Black
47	47	47	2.42	3.43	4.85	6.86	9.70	11.9	13.7	13.7	15.3		470		Yellow	Violet	Black
51	—	—	2.52	3.57	5.05	7.14	10.1	12.4	14.3	14.3	16.0		510		Green	Brown	Black
56	56	—	2.65	3.74	5.29	7.48	10.6	13.0	15.0	15.0	16.7		560		Green	Blue	Black
62	—	—	2.78	3.94	5.57	7.87	11.1	13.6	15.7	15.7	17.6		620		Blue	Red	Black
68	68	68	2.92	4.12	5.83	8.25	11.7	14.3	16.5	16.5	18.4		680		Blue	Gray	Black
75	—	—	3.06	4.33	6.12	8.66	12.2	15.0	17.3	17.3	19.4		750		Violet	Green	Black
82	82	—	3.20	4.53	6.40	9.06	12.8	15.7	18.1	18.1	20.2		820		Gray	Red	Black
91	—	—	3.37	4.77	6.74	9.54	13.5	16.5	19.1	19.1	21.3		910		White	Brown	Black
100	100	100	3.54	5.00	7.07	10.0	14.1	17.3	20.0	20.0	22.4		101		Brown	Black	Brown
110	—	—	3.71	5.24	7.42	10.5	14.8	18.2	21.0	21.0	23.5		111		Brown	Brown	Brown
120	120	—	3.87	5.48	7.75	11.0	15.5	19.0	21.9	21.9	24.5		121		Brown	Red	Brown
130	—	—	4.03	5.70	8.06	11.4	16.1	19.7	22.8	22.8	25.5		131		Brown	Orange	Brown
150	150	150	4.33	6.12	8.66	12.2	17.3	21.2	24.5	24.5	27.4		151		Brown	Green	Brown
160	—	—	4.47	6.32	8.94	12.6	17.9	21.9	25.3	25.3	28.3		161		Brown	Blue	Brown
180	180	—	4.74	6.71	9.49	13.4	19.0	23.2	26.8	26.8	30.0		181		Brown	Gray	Brown
200	—	—	5.00	7.07	10.0	14.1	20.0	24.5	28.3	28.3	31.6		201		Red	Black	Brown
220	220	220	5.24	7.42	10.5	14.8	21.0	25.7	29.7	29.7	33.2		221		Red	Red	Brown
240	—	—	5.48	7.75	11.0	15.5	21.9	26.8	31.0	31.0	34.6		241		Red	Yellow	Brown
270	270	—	5.81	8.22	11.6	16.4	23.2	28.5	32.9	32.9	36.7		271		Red	Violet	Brown
300	—	—	6.12	8.66	12.2	17.3	24.5	30.0	34.6	34.6	38.7		301		Orange	Black	Brown
330	330	330	6.42	9.08	12.8	18.2	25.7	31.5	36.3	36.3	40.6		331		Orange	Orange	Brown
360	—	—	6.71	9.49	13.4	19.0	26.8	32.9	37.9	37.9	42.4		361		Orange	Blue	Brown
390	390	—	6.98	9.87	14.0	19.7	27.9	34.2	39.5	39.5	44.2		391		Orange	White	Brown
430	—	—	7.33	10.4	14.7	20.7	29.3	35.9	41.5	41.5	46.4		431		Yellow	Orange	Brown
470	470	470	7.66	10.8	15.3	21.7	30.7	37.6	43.4	43.4	48.5		471		Yellow	Violet	Brown

[1] Rating at 70° C, derated to zero at 130° C.
[2] Rating at 70° C, derated to zero at 150° C.
[3] Rating at 40° C, derated to zero at 150° C.

Standard resistance values

Nominal Resistance in Ohms			Rated Continuous Working Voltage (RCWV) DC or RMS Volts									Resistor Part Number			Resistance Color Code		
TOLERANCE COLOR CODE			WATTAGE and TYPE									Type		Tolerance			
4th BAND			⅛ [1]	¼ [2]	½ [2]	1 [2]	2 [2]	3 [2]	4 [3]	4 [2]	5 [3]	BB CB EB etc	Value Code	5 = 5% 1 = 10% 2 = 20%	1st BAND	2nd BAND	3rd BAND
Gold ± 5%	Silver ± 10%	None ± 20%	BB	CB	EB	GB	HB	GM	GM	HM	HM	XX	000	X	1st digit	2nd digit	Number of zeros after 1st and 2nd digit
510	—	—	7.98	11.3	16.0	22.6	31.9	39.1	45.2	45.2	50.5		511		Green	Brown	Brown
560	560	—	8.37	11.8	16.7	23.7	33.5	41.0	47.3	47.3	52.9		561		Green	Blue	Brown
620	—	—	8.80	12.4	17.6	24.9	35.2	43.1	49.8	49.8	55.7		621		Blue	Red	Brown
680	680	680	9.22	13.0	18.4	26.1	36.9	45.2	52.2	52.2	58.3		681		Blue	Gray	Brown
750	—	—	9.68	13.7	19.4	27.4	38.7	47.4	54.8	54.8	61.2		751		Violet	Green	Brown
820	820	—	10.1	14.3	20.2	28.6	40.5	49.6	57.3	57.3	64.0		821		Gray	Red	Brown
910	—	—	10.7	15.1	21.3	30.2	42.7	52.2	60.3	60.3	67.5		911		White	Brown	Brown
1000	1000	1000	11.2	15.8	22.4	31.6	44.7	54.8	63.2	63.2	70.7		102		Brown	Black	Red
1100	—	—	11.7	16.6	23.4	33.2	46.9	57.4	66.3	66.3	74.2		112		Brown	Brown	Red
1200	1200	—	12.2	17.3	24.5	34.6	49.0	60.0	69.3	69.3	77.5		122		Brown	Red	Red
1300	—	—	12.8	18.0	25.5	36.1	51.0	62.4	72.1	72.1	80.6		132		Brown	Orange	Red
1500	1500	1500	13.7	19.4	27.4	38.7	54.8	67.1	77.5	77.5	86.6		152		Brown	Green	Red
1600	—	—	14.1	20.0	28.3	40.0	56.6	69.3	80.0	80.0	89.4		162		Brown	Blue	Red
1800	1800	—	15.0	21.2	30.0	42.4	60.0	73.5	84.8	84.8	94.9		182		Brown	Gray	Red
2000	—	—	15.8	22.4	31.6	44.7	63.2	77.5	89.4	89.4	100		202		Red	Black	Red
2200	2200	2200	16.6	23.4	33.2	46.9	66.3	81.2	93.8	93.8	105		222		Red	Red	Red
2400	—	—	17.4	24.5	34.6	49.0	69.3	84.8	98.0	98.0	110		242		Red	Yellow	Red
2700	2700	—	18.4	26.0	36.7	52.0	73.5	90.0	104	104	116		272		Red	Violet	Red
3000	—	—	19.4	27.4	38.7	54.8	77.5	94.9	110	110	122		302		Orange	Black	Red
3300	3300	3300	20.3	28.7	40.6	57.4	81.2	99.5	115	115	128		332		Orange	Orange	Red
3600	—	—	21.2	30.0	42.4	60.0	84.8	104	120	120	134		362		Orange	Blue	Red
3900	3900	—	21.1	31.2	44.2	62.4	88.3	108	125	125	140		392		Orange	White	Red
4300	—	—	23.2	32.8	46.4	65.6	92.7	114	131	131	147		432		Yellow	Orange	Red
4700	4700	4700	24.2	34.3	48.5	68.6	97.0	119	137	137	153		472		Yellow	Violet	Red
5100	—	—	25.2	35.7	50.5	71.4	101.0	124	143	143	160		512		Green	Brown	Red
5600	5600	—	26.5	37.4	52.9	74.8	106	130	150	150	167		562		Green	Blue	Red
6200	—	—	27.8	39.4	55.7	78.7	111	136	157	157	176		622		Blue	Red	Red
6800	6800	6800	29.2	41.2	58.3	82.5	117	143	165	165	184		682		Blue	Gray	Red
7500	—	—	30.6	43.3	61.2	86.6	122	150	173	173	194		752		Violet	Green	Red
8200	8200	—	32.0	45.3	64.0	90.6	128	157	181	181	202		822		Gray	Red	Red
9100	—	—	33.7	47.7	67.4	95.4	135	165	191	191	213		912		White	Brown	Red
10000	10000	10000	35.4	50.0	70.7	100.0	141	173	200	200	224		103		Brown	Black	Orange
11000	—	—	37.1	52.4	74.2	105	148	182	210	210	235		113		Brown	Brown	Orange
12000	12000	—	38.7	54.8	77.5	110	155	190	219	219	245		123		Brown	Red	Orange
13000	—	—	40.3	57.0	80.6	114	161	197	228	228	255		133		Brown	Orange	Orange
15000	15000	15000	43.3	61.2	86.6	122	173	212	245	245	274		153		Brown	Green	Orange
16000	—	—	44.7	63.2	89.4	126	179	219	253	253	283		163		Brown	Blue	Orange
18000	18000	—	47.4	67.1	94.9	134	190	232	268	268	300		183		Brown	Gray	Orange
20000	—	—	50.0	70.7	100.0	141	200	245	283	283	316		203		Red	Black	Orange
22000	22000	22000	52.4	74.2	105	148	210	257	297	297	332		223		Red	Red	Orange
24000	—	—	54.8	77.5	110	155	219	268	310	310	346		243		Red	Yellow	Orange
27000	27000	—	58.1	82.2	116	164	232	285	329	329	367		273		Red	Violet	Orange
30000	—	—	61.2	86.6	122	173	245	300	346	346	387		303		Orange	Black	Orange
33000	33000	33000	64.2	90.8	128	182	257	315	363	363	406		333		Orange	Orange	Orange
36000	—	—	67.1	94.9	134	190	268	329	379	379	424		363		Orange	Blue	Orange
39000	39000	—	69.8	98.7	140	197	279	342	395	395	442		393		Orange	White	Orange
43000	—	—	73.3	104	147	207	293	359	415	415	464		433		Yellow	Orange	Orange
47000	47000	47000	76.6	108	153	217	307	376	434	434	485		473		Yellow	Violet	Orange
51000	—	—	79.8	113	160	226	319	391	452	452	505		513		Green	Brown	Orange
56000	56000	—	83.7	118	167	237	335	410	473	473	529		563		Green	Blue	Orange
62000	—	—	88.0	124	176	249	352	431	498	498	557		623		Blue	Red	Orange
68000	68000	68000	92.2	130	184	261	369	452	500	522	583		683		Blue	Gray	Orange
75000	—	—	96.8	137	194	274	387	474	500	548	612		753		Violet	Green	Orange
82000	82000	—	101	143	202	286	405	496	500	573	640		823		Gray	Red	Orange
91000	—	—	107	151	213	302	427	500	500	603	675		913		White	Brown	Orange
Nominal Resistance in Megohms																	
0.1	0.1	0.1	112	158	224	316	447	500	500	632	707		104		Brown	Black	Yellow
0.11	—	—	117	166	234	332	469	500	500	663	742		114		Brown	Brown	Yellow
0.12	0.12	—	122	173	245	346	490	500	500	693	750		124		Brown	Red	Yellow
0.13	—	—	128	180	255	361	510	500	500	721	750		134		Brown	Orange	Yellow
0.15	0.15	0.15	137	194	274	387	548	500	500	750	750		154		Brown	Green	Yellow
0.16	—	—	141	200	283	400	566	500	500	750	750		164		Brown	Blue	Yellow
0.18	0.18	—	150	212	300	424	600	500	500	750	750		184		Brown	Gray	Yellow
0.20	—	—	150	224	316	447	632	500	500	750	750		204		Red	Black	Yellow
0.22	0.22	0.22	150	234	332	469	663	500	500	750	750		224		Red	Red	Yellow
0.24	—	—	150	245	346	490	693	500	500	750	750		244		Red	Yellow	Yellow

[1] Rating at 70° C, derated to zero at 130° C.
[2] Rating at 70° C, derated to zero at 150° C.
[3] Rating at 40° C, derated to zero at 150° C.

Standard resistance values

Nominal Resistance in Ohms — TOLERANCE COLOR CODE (4th BAND)			Rated Continuous Working Voltage (RCWV) DC or RMS Volts — WATTAGE and TYPE									Resistor Part Number			Resistance Color Code		
												Type		Tolerance			
Gold ± 5%	Silver ± 10%	None ± 20%	⅛ W [1]	¼ W [2]	½ W [2]	1 W [2]	2 W [2]	3 W [2]	4 W [3]	4 W [2]	5 W [3]	BB CB EB etc.	Value Code	5 = 5% 1 = 10% 2 = 20%	1st BAND 1st digit	2nd BAND 2nd digit	3rd BAND Number of zeros after 1st and 2nd digit
			BB	CB	EB	GB	HB	GM	GM	HM	HM	XX	000	X			
0.27	0.27	—	150	250	350	500	735	500	500	750	750		274		Red	Violet	Yellow
0.30	—	—	150	250	350	500	750	500	500	750	750		304		Orange	Black	Yellow
0.33	0.33	0.33	150	250	350	500	750	500	500	750	750		334		Orange	Orange	Yellow
0.36	—	—	150	250	350	500	750	500	500	750	750		364		Orange	Blue	Yellow
0.39	0.39	—	150	250	350	500	750	500	500	750	750		394		Orange	White	Yellow
0.43	—	—	150	250	350	500	750	500	500	750	750		434		Yellow	Orange	Yellow
0.47	0.47	0.47	150	250	350	500	750	500	500	750	750		474		Yellow	Violet	Yellow
0.51	—	—	150	250	350	500	750	500	500	750	750		514		Green	Brown	Yellow
0.56	0.56	—	150	250	350	500	750	500	500	750	750		564		Green	Blue	Yellow
0.62	—	—	150	250	350	500	750	500	500	750	750		624		Blue	Red	Yellow
0.68	0.68	0.68	150	250	350	500	750	500	500	750	750		684		Blue	Gray	Yellow
0.75	—	—	150	250	350	500	750	500	500	750	750		754		Violet	Green	Yellow
0.82	0.82	—	150	250	350	500	750	500	500	750	750		824		Gray	Red	Yellow
0.91	—	—	150	250	350	500	750	500	500	750	750		914		White	Brown	Yellow
1.0	1.0	1.0	150	250	350	500	750	500	500	750	750		105		Brown	Black	Green
1.1	—	—	150	250	350	500	750	500	500	750	750		115		Brown	Brown	Green
1.2	1.2	—	150	250	350	500	750	500	500	750	750		125		Brown	Red	Green
1.3	—	—	150	250	350	500	750	500	500	750	750		135		Brown	Orange	Green
1.5	1.5	1.5	150	250	350	500	750	500	500	750	750		155		Brown	Green	Green
1.6	—	—	150	250	350	500	750	500	500	750	750		165		Brown	Blue	Green
1.8	1.8	—	150	250	350	500	750	500	500	750	750		185		Brown	Gray	Green
2.0	—	—	150	250	350	500	750	500	500	750	750		205		Red	Black	Green
2.2	2.2	2.2	150	250	350	500	750	500	500	750	750		225		Red	Red	Green
2.4	—	—	150	250	350	500	750	500	500	750	750		245		Red	Yellow	Green
2.7	2.7	—	150	250	350	500	750	500	500	750	750		275		Red	Violet	Green
3.0	—	—	150	250	350	500	750	500	500	750	750		305		Orange	Black	Green
3.3	3.3	3.3	150	250	350	500	750	500	500	750	750		335		Orange	Orange	Green
3.6	—	—	150	250	350	500	750	500	500	750	750		365		Orange	Blue	Green
3.9	3.9	—	150	250	350	500	750	500	500	750	750		395		Orange	White	Green
4.3	—	—	150	250	350	500	750	500	500	750	750		435		Yellow	Orange	Green
4.7	4.7	4.7	150	250	350	500	750	500	500	750	750		475		Yellow	Violet	Green
5.1	—	—	150	250	350	500	750	500	500	750	750		515		Green	Brown	Green
5.6	5.6	—	150	250	350	500	750	500	500	750	750		565		Green	Blue	Green
6.2	—	—	150	250	350	500	750	500	500	750	750		625		Blue	Red	Green
6.8	6.8	6.8	150	250	350	500	750	500	500	750	750		685		Blue	Gray	Green
7.5	—	—	150	250	350	500	750	500	500	750	750		755		Violet	Green	Green
8.2	8.2	—	150	250	350	500	750	500	500	750	750		825		Gray	Red	Green
9.1	—	—	150	250	350	500	750	500	500	750	750		915		White	Brown	Green
10	10	10	150	250	350	500	750	500	500	750	750		106		Brown	Black	Blue
11	—	—	150	250	350	500	750	500	500	750	750		116		Brown	Brown	Blue
12	12	—	150	250	350	500	750	500	500	750	750		126		Brown	Red	Blue
13	—	—	150	250	350	500	750	500	500	750	750		136		Brown	Orange	Blue
15	15	15	150	250	350	500	750	500	500	750	750		156		Brown	Green	Blue
16	—	—	150	250	350	500	750	500	500	750	750		166		Brown	Blue	Blue
18	18	—	150	250	350	500	750	500	500	750	750		186		Brown	Gray	Blue
20	—	—	150	250	350	500	750	500	500	750	750		206		Red	Black	Blue
22	22	22	150	250	350	500	750	500	500	750	750		226		Red	Red	Blue
24	—	—	150	250	350	500	750	500	500	750	750		246		Red	Yellow	Blue
27	27	—	150	250	350	500	750	500	500	750	750		276		Red	Violet	Blue
30	—	—	150	250	350	500	750	500	500	750	750		306		Orange	Black	Blue
33	33	33	150	250	350	500	750	500	500	750	750		336		Orange	Orange	Blue
36	—	—	150	250	350	500	750	500	500	750	750		366		Orange	Blue	Blue
39	39	—	150	250	350	500	750	500	500	750	750		396		Orange	White	Blue
43	—	—	150	250	350	500	750	500	500	750	750		436		Yellow	Orange	Blue
47	47	47	150	250	350	500	750	500	500	750	750		476		Yellow	Violet	Blue
51	—	—	150	250	350	500	750	500	500	750	750		516		Green	Brown	Blue
56	56	—	150	250	350	500	750	500	500	750	750		566		Green	Blue	Blue
62	—	—	150	250	350	500	750	500	500	750	750		626		Blue	Red	Blue
68	68	68	150	250	350	500	750	500	500	750	750		686		Blue	Gray	Blue
75	—	—	150	250	350	500	750	500	500	750	750		756		Violet	Green	Blue
82	82	—	150	250	350	500	750	500	500	750	750		826		Gray	Red	Blue
91	—	—	150	250	350	500	750	500	500	750	750		916		White	Brown	Blue
100	100	100	150	250	350	500	750	500	500	750	750		107		Brown	Black	Violet

[1] Rating at 70° C, derated to zero at 130° C.
[2] Rating at 70° C, derated to zero at 150° C.
[3] Rating at 40° C, derated to zero at 150° C.

EXPLANATION OF PART NUMBERS

All Allen-Bradley fixed composition resistors are identified by a Part Number which will provide information as to the type of resistor, resistance value, and tolerance. The Part Number is merely for identification on drawings, specifications, ordering, and other areas where it is convenient to use a Part Number to describe a particular resistor. The only markings that appear on the resistor are the Color Code bands.

INDUSTRIAL TYPE DESIGNATION → EB5145

Type or Style

Allen-Bradley	Rating (Watts) (at 70° C)	MIL-R-11 Style	MIL-R-39008 Style
BB	1/8	RC05	RCR05
CB	1/4	RC07	RCR07
EB	1/2	RC20	RCR20
GB	1	RC32	RCR32
HB	2	RC42	RCR42
GM	3	—	—
HM	4	—	—

Type

Fixed Composition Resistors, Insulated, Established Reliability

Resistance

Expressed in ohms and identified by a three-digit number. First two digits represent significant figures. Last digit specifies the number of zeros to follow, except below 10 ohms (see below).

FOR VALUES BELOW 10 OHMS:

ALLEN-BRADLEY DESIGNATION	MIL DESIGNATION
The letter "G" is substituted in place of the third digit. The desired resistance value is then the first two digits multiplied by 0.1.	The letter "R" is substituted in place of a significant digit to represent the decimal point. The following digits represent significant figures.

EXAMPLE

Allen-Bradley	Resistance	MIL Designation
27G	2.7 Ohm	2R7

RESISTANCE TOLERANCE

Allen-Bradley	Tolerance	MIL Designation
5	± 5%	J
1	± 10%	K
2	± 20%	—

FAILURE RATE LEVEL

At 50% rated wattage expressed in %/1000 hrs.

M = 1.0%
P = 0.1%
R = 0.01%
S = 0.001%

MIL-R-39008 TYPE DESIGNATION → RCR 20 G514 JS

MIL-R-11 TYPE DESIGNATION → RC20 GF514J

MAXIMUM AMBIENT TEMPERATURE AND RESISTANCE TEMPERATURE CHARACTERISTIC
(Refer to MIL-R-11 or MIL-R-39008 Specifications as Applicable)

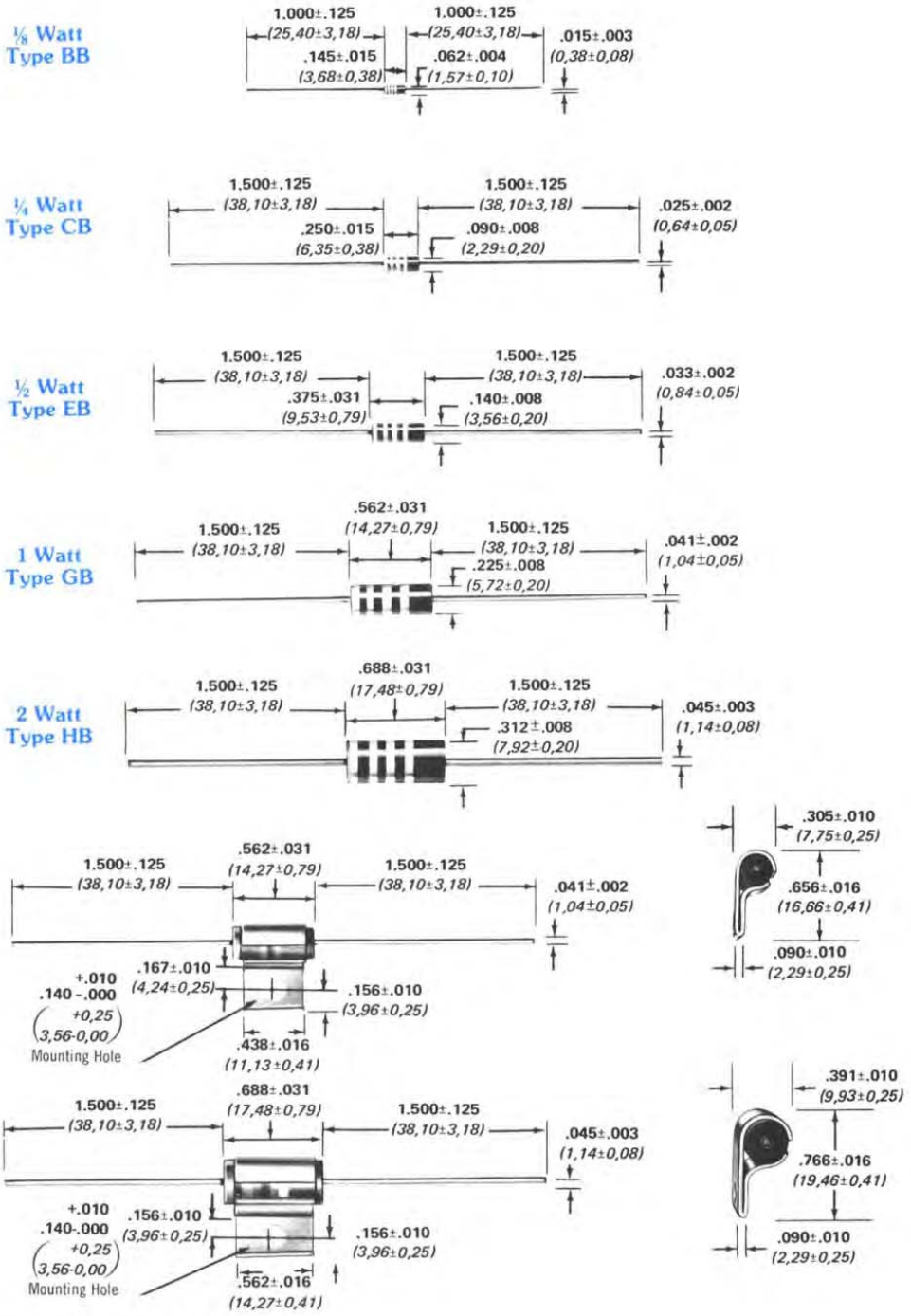
Standard color code and preferred number series

Color	Digit	Multiplier	Tolerance	Reliability Level (Percent Per 1000 Hours) (When Applicable)
Black	0	1	—	—
Brown	1	10	—	M = 1.0%
Red	2	100	—	P = 0.1%
Orange	3	1000	—	R = 0.01%
Yellow	4	10,000	—	S = 0.001%
Green	5	100,000	—	—
Blue	6	1,000,000	—	—
Violet	7	10,000,000	—	—
Gray	8	—	—	—
White	9	—	—	—
Gold	—	0.1	± 5%	—
Silver	—	—	± 10%	—
No color	—	—	± 20%	—

Perferred Number Series

± 5% Tolerance (E24)	10	15	22	33	47	68
	11	16	24	36	51	75
	12	18	27	39	56	82
	13	20	30	43	62	91
± 10% Tolerance (E12)	10	15	22	33	47	68
	12	18	27	39	56	82
± 20% Tolerance (E6)	10	15	22	33	47	68

DIMENSIONS



Dimensions shown in parentheses are in millimeters.

Types BB, CB, EB, GB HB, GM, HM Hot-Molded Fixed Resistors

EVALUATION TESTS

- Measurement Methods
- Test Procedures
- Test Sequence

General — This publication defines standardized methods for testing discrete fixed resistors, including basic environmental tests to determine the ability of the resistor to withstand climatic stresses, as well as physical and electrical tests to determine production assembly durability and operational life. The laboratory conditions specified are designed to give results which are indicative of what may be observed under similar stresses which may be encountered in field use. However, they are not intended to be exact or conclusive representations of any specific actual service operation. They are intended to be standardized such that reproducible results can be obtained in repetitive tests or comparison evaluations.

Standard test conditions — Unless otherwise specified herein, or in applicable referenced specifications, all measurements and tests shall be made at temperatures of +15°C to +35°C, at air pressure of 650 to 800 millimeters of mercury, and relative humidity of 45 percent to 75 percent. Whenever these conditions must be closely controlled in order to obtain reproducible results, for referee purposes the ambient temperature shall be 23°C ± 1°C, and the humidity 50 percent ± 2 percent.

Cross reference — At the end of this publication is a cross index table comparing these test methods to similar procedures specified in applicable military or industrial specifications. Wherever the tests are not identical, notations are given regarding the differences.

Resistance measuring techniques — Measured resistance value is dependent upon the resistor temperature, the test voltage, and the degree of resistor dryness. Accurate correlation between repeated measurements, especially at different times, and different locations, requires that these three conditions be essentially the same.

Slight variations in resistor body temperature are not significant in room temperature measurements. However, the temperature of the resistor body may increase appreciably when tested at too high a voltage or when the voltage is applied for too long a time causing excessive heating.

For accurate measurements to determine the resistance value tolerance, the test voltage is very important and sometimes misunderstood or overlooked. This is because a tester is often unaware of the actual voltage that an instrument may be applying to the resistor under test. Commonly used instruments such as highly accurate resistance bridges or digital voltmeters employ relatively low voltages to make measurements, usually around 1 volt and seldom higher than 10 volts. This does not cause significant differences for low resistance values where the use of low test voltages is specified. However, for higher resistance values such as 100K ohms or higher, a test voltage of 100 volts is specified and use of a low voltage test instrument will result in substantial difference in readings. For comparison measurements to determine the resistance change which may occur due to some electrical or environmental stress, either the standard test voltage or a low voltage may be used, since only the resistance change is being examined, independent of the absolute resistance value. The principal requirement is that the same meter be used for both initial and final measurements.

It is important to recognize that apparent out-of-tolerance on the + side can be caused by excessive exposure to high humidity. To eliminate this potential humidity offset, all test samples are to be conditioned in accordance with Paragraph 3.2 prior to commencement of testing. In this manner, the effects of any electrical or environmental stress can be examined separately, without any confusion with possible moisture resistance offset.

1. SCOPE

1.1 Scope — The tests described in this publication are considered appropriate for the evaluation of molded and film type composition resistors.

2. DEFINITIONS

2.1 Power ratings — The maximum continuous power ratings of Allen-Bradley resistors are as indicated in Table 1 on Page 31, and are dependent on the ability of resistors to meet the load life test requirements. See Allen-Bradley Technical Publication EC5021-2.1 for rating details.

2.2 Voltage rating — The maximum rated continuous working voltage (RCWV max.), DC or sine wave RMS at commercial line frequency, which must not exceed the maximum listed in Table 1, is equal to $\sqrt{PR}$, where P is the power rating in watts and R is the nominal resistance in ohms.

3. SAMPLE SELECTION

3.1 Sample selection — Resistors with the narrowest standard commercial tolerance shall be used. Resistance values selected for test shall include the lowest and highest standard values listed by the manufacturer, also the critical values. The critical resistance value is defined as the lowest standard value to which maximum rated continuous working voltage can be applied without exceeding rated continuous wattage at + 70° C ambient temperature. See Table 1. Ten resistors of each type and resistance value should be used for each test group.

3.2 Conditioning — Resistors which are NOT truly hermetically sealed by means of enclosures made of metal, glass or ceramic material with appropriate seals, must first be treated in accordance with Paragraph 7, Conditioning. After conditioning, such resistors should be kept in a desiccator except when under another specified test environment in accordance with the test requirements of Table 2 on Page 31.

4. TESTING SEQUENCE

4.1 Testing sequence — All resistor test specimens shall be subjected to Group 1 tests. Separate samples selected from those tested under Group 1 shall be used for each additional test group. Within a group, tests shall be conducted in the order specified.

5. RESISTANCE MEASUREMENTS

5.1 Resistance measurements — Resistance measurement error shall not exceed one-tenth the allowable resistance change due to testing or 0.5 percent, whichever is less. Unless otherwise specified, the same instrument, temperature (within ±2°C), and DC test voltage listed in the table below (because of instantaneous voltage characteristic) applied for as short a time as *practicable (to avoid heating during the measurement)*, shall be used throughout any one of the performance characteristic tests. Wheatstone Bridge test equipment is preferred.

5.2 Reference test voltages — In the event of a difference in resistance readings attributable to the test voltage used, the specified test voltage listed below shall be used.

Nominal Resistance Range	Recommended Test Voltages (DC Volts)
1.0 to 9.1 ohms	0.3
10 to 91 ohms	1.0
100 to 910 ohms	3.0
1K to 9.1K ohms	10
10K to 91K ohms	30
0.1 Meg. and Higher	100

6. PERFORMANCE CHARACTERISTICS

6.1 Visual and Mechanical Inspection — Conformance with manufacturer's catalog specifications shall be verified.

6.2 Resistance tolerance — Resistance shall not exceed the specified limits when measured at + 25°C ± 2°C using the test voltages listed above.

6.3 Resistance-temperature characteristic

6.3.1 Procedure — Resistors shall be maintained within ± 1°C at each of the ambient temperatures listed in Table 3 on Page 31, and in the order shown. The use of forced circulating air is recommended to assure temperature stability and uniformity. Resistance measurements shall be made at each temperature 15 minutes after air temperature has stabilized at the specified temperature. The percent difference in resistance referred to the resistance at + 25°C shall be computed with the following formula:

$$\text{Percent Resistance Difference} = \frac{(R - r) \times 100}{r}$$

Where: R is the resistance at test temperature
r is the resistance at + 25°C

6.4 Resistance-voltage coefficient

6.4.1 Significance — The instantaneous voltage coefficient is normally important only with respect to incoming inspection testing and in the comparison of results obtained in evaluation testing.

6.4.2 Procedure — The resistance shall be measured at one-tenth the RCWV and at full RCWV. Application of voltages shall be momentary to minimize heating effects. The resistance-voltage coefficient shall be calculated with the following formula:

$$\frac{\text{Voltage Coefficient}}{\text{Percent Per Volt}} = \frac{(R - r) \times 100}{r \times 0.9\ (RCWV)}$$

Where: R is the resistance at full RCWV
r is the resistance at one-tenth RCWV

6.5 Dielectric withstanding voltage

6.5.1 Mounting — The resistors shall be clamped in the trough of a 90° metallic V-block of such size that the resistor body does not extend beyond the ends of the trough. The resistor leads shall be positioned such that they are no closer to the V-block than if they were parallel to the sides of the V-block. This prevents unnecessary proximity of the leads to the block, while permitting complete seating of the resistor body in the block.

6.5.2 Procedure — Sine wave RMS voltages from an alternating current supply at commercial line frequency not more than 100 Hertz as specified in Table 1 shall be applied at the rate of approximately 100 volts per second between resistor terminals connected together and the V-block, and held for 5 seconds.

6.5.2.1 Sea level atmospheric pressure — The procedure in 6.5.2 shall be carried out at a normal sea level atmospheric pressure of approximately 30 inches (1016 mbars) mercury using the appropriate voltage specified in Table 1.

6.5.2.2 High altitude atmospheric pressure — The procedure in 6.5.2 shall be carried out at a pressure of approximately 3.4 inches (115 mbars) mercury using the appropriate voltage specified in Table 1. This pressure is approximately equivalent to an altitude of 50,000 feet (15240 meters).

6.6 Insulation resistance

6.6.1 Mounting — Resistors shall be clamped between a round non-conducting rod at right angles to the resistor body and a conducting resilient material approximately

0.075 inch (1,90 mm) thick conductively attached or bonded to a rigid metal strap. See Figure 1. The clamping pressure shall be such as to embed the resistor color bands in the resilient material and provide intimate electrical contact over the entire length of the resistor body along a surface line parallel to the longitudinal axis of the resistor. The metal strap and resilient conductive coating shall be at least as wide as the length of the resistor body, and the resistor body shall be approximately centered on the strap. See Figure 1. For types GM and HM, connection may be made to the attached metal clamp in lieu of the coated metal strap described above. The resistivity of the resilient conducting material shall be less than 1000 ohm-centimeters.

6.6.2 Procedure — Avoiding excessive handling to minimize the effects of perspiration or other contaminants, connect the lead wires of the resistor together and measure the resistance between them and the metal strap using a DC test voltage as specified in Table 1.

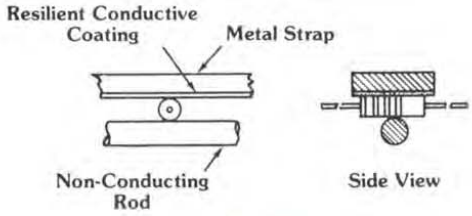


Figure 1

6.7 Low temperature operation

6.7.1 Mounting — Resistors shall be mounted by their leads so that there is at least 1 inch (25,40 mm) of free air space around each resistor and the mounting is in such a position with respect to the air stream that it offers no appreciable obstruction to the flow of air across and around the resistors.

6.7.2 Procedure — Initial resistance shall be measured. The resistors shall then be exposed to the air stream at −65°C (+ 0°C, − 5°C) for 1 hour with no voltage applied, and then 45 minutes with the RCWV applied, after which the resistors shall be placed at room temperature. Approximately 24 hours after return to room temperature, final resistance shall be measured.

6.8 Thermal shock

6.8.1 Procedure — Initial resistance shall be measured. Mounted as specified in 6.7.1, the resistors shall be subjected to the temperature cycle specified in Table 4 on Page 31 for a total of five cycles, performed continuously. Temperatures in Steps 1 and 3 shall be maintained by forced air circulation. The hot and cold chambers shall be of such capacity that the air temperature will reach the temperatures specified in Table 4 within 2 minutes after the resistors have been placed in the appropriate chamber. Final resistance shall be measured approximately 1 hour after completion of the fifth cycle.

6.9 Moisture resistance

6.9.1 Mounting — The resistors shall be fastened by their leads to suitable supports (to insure no mechanical resonances between 10 and 55 Hertz) so that the length of each lead between the resistor body and the support is 3/8 inch (9, 52 mm).

6.9.2 Procedure

6.9.2.1 Cycles — Ten cycles shall be performed as specified in Figure 2.

6.9.2.2 Load — During the first 2 hours of Steps 1 and 4, DC RCWV shall be applied to half the resistors of each type and resistance value on test.

6.9.2.3 Vibration — The mounted resistors shall be subjected to a simple harmonic motion having a maximum amplitude of 0.06 inch (0,15 mm) peak-to-peak, the frequency being varied uniformly from 10 to 55 and back to 10 Hertz in one minute. This motion shall be applied in a direction perpendicular to the longitudinal axis of the resistors.

6.9.2.4 Measurements — Initial resistance shall be measured before the test. After Step 6 in the final cycle, the resistors shall be exposed to a temperature of + 25°C ± 2°C and a relative humidity of 90 to 98 percent, for 1-1/2 to 3-1/2 hours. Upon removal from the test chamber, resistors shall be permitted to dry for a maximum of 4 hours at + 25°C ± 5°C at no less than 50 percent relative humidity. Such drying atmosphere shall not be forced, circulating air. At the end of the drying period, final resistance and insulation resistance (per 6.6) shall be measured.

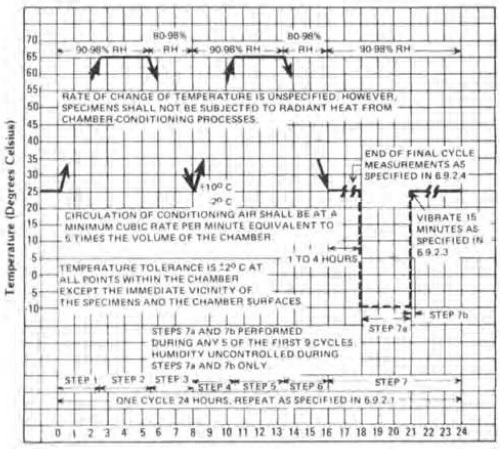


Figure 2

6.10 Humidity characteristic (steady state)

6.10.1 Significance — Results from the moisture resistance testing specified in 6.9 have been found to vary because of the equipment required, and because the results obtained are largely a function of the particular apparatus used, size of chamber, etc. Results obtained with one apparatus cannot be directly compared with results obtained with other apparatus. The following steady state humidity test is recommended in place of the moisture resistance test in order to obtain better isolation of the effects of moisture.

6.10.2 Procedure — Initial resistance values shall be measured. Excessive handling and surface contamination shall be avoided. Resistors shall then be placed in a chamber at a relative humidity of 90 to 95 percent at an ambient temperature of + 40°C ± 2°C for a period of 240 hours. After removal from the chamber, the resistors shall be allowed to dry at room ambient for 4 hours to remove surface moisture following which final resistance measurements shall be made. The resistors may then be subjected to the conditioning described in Paragraph 7 to determine whether the resistance changes due to moisture are permanent.

6.11 Short time overload

6.11.1 Procedure — A well regulated DC or sine wave RMS voltage 2.5 times (2 times for Types GM and HM) the RCWV, but not exceeding the limit values listed in Table 1, shall be applied for 5 seconds. Resistance shall be measured before and approximately 30 minutes after the application of the test voltage.

6.12 Load life

6.12.1 Test conditions — This test shall be conducted at an ambient temperature of +70°C ±2°C. Resistors shall be mounted by their leads soldered to lightweight terminals, and, in addition, for Types GM and HM, their metal clamps should be bolted to a 4 inch (101,60 mm) square steel plate 0.050 inch (1,27 mm) thick, one plate per resistor. The effective length of each lead shall be 1±3/16 inch (25,40 ± 4,76 mm). Resistors shall be so arranged that the heat from any one resistor will not appreciably influence the temperature of any other resistor. There shall be no circulation of air directly over any resistor other than that caused by the heat of that resistor itself. RCWV shall be used.

6.12.2 Procedure — After exposure of the resistors to the + 70°C ambient test temperature without load for 2 hours, initial resistances shall be measured at the test ambient temperature. Then DC RCWV shall be applied intermittently 1-1/2 hour "ON", 1/2 hour "OFF" for a total of 1000 hours. Resistance measurements shall be made near the end of the 1/2 hour "OFF" periods at the test ambient temperature after 50 ± 8, 100 ± 8, 250 ± 8, 500 ±12, 750 ± 12, and 1000 ± 12 hours have elapsed from the time the RCWV was first applied.

6.13 Terminal strength

6.13.1 Procedure

6.13.1.1 Pull — Initial resistance shall be measured. Resistor shall then be held by one lead, and a tensile force of 5 pounds (2,27 kgm) (2 pounds [0,91 kgm] for Type BB) shall be gradually applied to the other lead in the direction of the longitudinal axis of the resistor. The specified force shall be maintained for 5 seconds.

6.13.1.2 Twist — Following the test in 6.13.1.1, the leads shall be bent 90° at a point 1/4 ± 1/64 inch (6,35 ± 0,40 mm) from the resistor body with the radius of curvature at the bend approximately 1/32 inch (0,80 mm). The free end of the lead shall be clamped at a point 3/64 ± 1/64 inch (1,19 ± 0,40 mm) away from the bend. See Figure 3. The

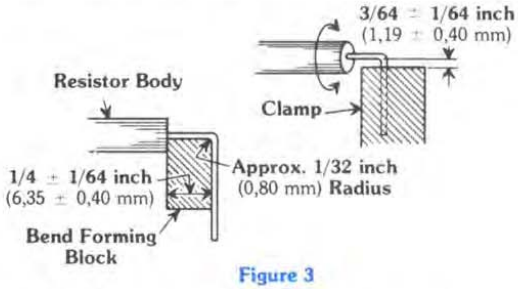


Figure 3

resistor body shall then be rotated about the original axis of the terminal through 360° in alternating directions for three such rotations, at the rate of approximately 5 seconds per rotation. After the final rotation, final resistance shall be measured.

6.14 Resistance to solder heat

6.14.1 Procedure — Initial resistance shall be measured. Resistor leads shall then be immersed, one at a time for 3 ± 1/2 seconds each, in molten solder at + 350°C ± 5°C (+ 250°C ± 5°C for Type BB) to a distance of 1/8 to 3/16 inch (3,18 to 4,76 mm) from the resistor body. Final resistance shall be measured 24 ± 4 hours after the immersions.

6.15 Solderability

6.15.1 Apparatus — A heated still pot or a recirculating flow type soldering machine capable of maintaining the solder at a uniform temperature of + 232°C ± 5°C shall be used. If a still pot is used, the stirring paddle and skimmer shall be made of stainless steel or other material which will not contaminate the solder. A dipping device capable of controlling the rate of immersion of resistor leads at 1 ± 1/4 inch (25,40 ± 6,35 mm) per second, and providing a dwell time of 5 ± 1/2 seconds in the solder bath shall be used. For examination, an optical system capable of 10 power magnification shall be used.

6.15.2 Materials — The flux shall consist of a minimum of 35 percent by weight waterwhite rosin dissolved in 99 percent isopropyl alcohol. Solder shall be nominally 60 percent tin, 40 percent lead solder, conforming to Type S, composition Sn60 of Specification QQ-S-571D. [1]

6.15.3 Procedure — Both leads of each resistor shall be tested in "as received" condition, with care taken to prevent handling or other contamination which may influence the results of this test. The leads shall be immersed in flux, sufficiently to cover the surfaces to be tested, for 5 to 10 seconds at room temperature. If a scum or dross has accumulated on the solder surface, it shall be skimmed off. If the solder is not circulating, it shall be stirred with the paddle to mix the solder and make the temperature uniform throughout. After stirring, the surface shall be skimmed again. The fluxed leads should then be dipped into the solder once, to the same depth they were immersed in flux, using the dipping apparatus. After dipping, the leads shall be allowed to cool in air. Residual flux may be removed from the leads by dipping in clean isopropyl alcohol and, if necessary, wiping with soft cloth. The surface of each lead shall be examined with the optical system.

6.16 Shock

6.16.1 Mounting — Resistors shall be mounted on appropriate fixtures with their leads supported at a distance of 1/4 inch (6,35 mm) from the resistor body. These fixtures shall be constructed so as to ensure that the points of the resistor mounting supports will have the same motion as the shock table. Test leads shall be 22 AWG or smaller, and of minimum length.

6.16.2 Apparatus — Apparatus shall be provided of such design as to impart a terminal-peak sawtooth shock pulse with a peak value of 100g and normal duration of 6 milliseconds. The actual velocity change must be within 10 percent of the ideal pulse velocity change of 9.7 ft/sec.

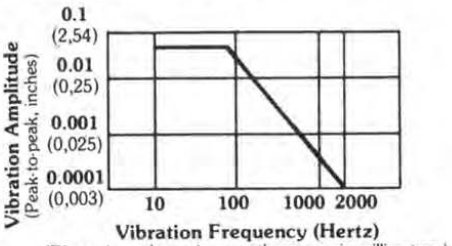
6.16.3 Procedure — Initial resistance shall be measured. The mounted resistors shall then be subjected to 10 impacts in each of two directions: parallel and perpendicular to the longitudinal axis of the resistor. Electrical monitoring shall be provided during the test to detect resistor discontinuities of 0.1 millisecond or greater duration. Final measurements and examination for mechanical failures shall be made after the test.

[1] QQ-S-571D — Available from Commanding Officer, Naval Supply Depot, 5801 Tabor Ave., Philadelphia, Pennsylvania 19120, provided a military contract is involved.

6.17 Vibration

6.17.1 Mounting — The mounting fixtures, with resistors mounted as in 6.16.1, shall be so constructed as to be free of mechanical resonances over the frequency range of 10 to 2000 Hertz.

6.17.2 Procedure — Initial resistance shall be measured. The mounted resistors shall then be subjected to the vibration amplitude and frequency range shown in Figure 4. The vibration waveform shall be a simple harmonic motion having an amplitude sufficient to provide 20g constant peak acceleration, but not to exceed 0.06 inch (1,52 mm) peak-to-peak amplitude. The frequency shall be varied approximately logarithmically between the nominal limits of 10 and 2000 Hertz with a return sweep to 10 Hertz. The entire sweep from 10 to 2000 to 10 Hertz shall be traversed in approximately 20 minutes. This sweep cycle shall be performed repeatedly for 6 hours in each of two directions: parallel and perpendicular to the longitudinal axis of the resistor. Interruptions are permitted provided requirements for rate of change and test duration are met. Electrical monitoring shall be provided during this test to detect resistor discontinuities of 0.1 millisecond or greater duration. Final measurements and examination for mechanical failures shall be made after the test.



(Dimensions shown in parentheses are in millimeters.)

Figure 4

6.18 Pulse applications

6.18.1 Significance — For circuit applications where pulses or transients whose peak values exceed steady state ratings are experienced, tests should be made to determine the suitabilty of the resistors being considered for use.

6.18.2 Procedure — In general, such tests should include life tests for at least 1000 hours under conditions which accurately represent the peak value, pulse waveform and repetition rate, under the environmental conditions which must be met. Tests under more severe conditions are recommended to establish the safety factors involved, bearing in mind that every type of resistor can be seriously damaged or completely destroyed if the stress levels are raised sufficiently. Such tests may be made by use of a noninductive capacitor of suitable capacitance value and voltage rating, charged at successively higher voltages and discharged each time through the resistor under test, arranging the circuitry for a minimum and consistent inductance value. Resistance measurements should be made, initially and after each capacitor discharge, by uniform method.

6.19 Color code solvent resistance

6.19.1 Procedure — The purpose of this test is to verify that the color code will not become eligible or discolored on the resistors when subjected to solvents normally used to clean printed wiring assemblies. The following solvents shall not cause mechanical or electrical damage and markings shall remain legible.

1. A 3 to 1 Mixture of mineral spirits and isopropyl alcohol.
2. 1-1-1 trichloroethane.
3. Freon TMC.

The test sample shall be divided into three equal groups, with one group subjected to solvent (1.), the second group to solvent (2.) and the third group to solvent (3.). The solutions shall be maintained at room temperature and samples immersed for one minute. Immediately following emersion, the resistor shall be brushed with a hard bristle toothbrush with normal hand pressure for ten strokes in a forward direction across the body surface. Immediately after brushing, this procedure shall be repeated two additional times. After five minutes after completion the resistor shall be examined.

6.20 Low temperature storage

6.20.1 Mounting — Resistor mounting shall be the same as described in 6.7.1.

6.20.2 Procedure — Initial resistance shall be measured. The resistors shall then be exposed to the air stream at $-65°C \pm 2°C$ for a period of 24 ± 4 hours, after which the resistors shall be placed at room temperature. After approximately 2 to 8 hours, final resistance shall be measured.

7. CONDITIONING

7.1 Significance — All resistors except those which are truly hermitically sealed by means of enclosures made of metal, glass or ceramic materials with appropriate seals such as metal to glass, or metal to ceramic, may absorb moisture which can affect resistance values to a varying degree, dependent upon their materials, construction, dimensions and the duration of exposure to atmospheres having a high relative humidity. To eliminate this variable from test results, moisture removal by conditioning with warm DRY air is mandatory if a meaningful comparison of results is desired. Use of a ventilated oven in an air conditioned space is recommended.

7.2 Procedure — Allen-Bradley resistors, as well as competitive makes of similar physical size, should be conditioned in DRY + 100°C (+5°C, − 0°C) air for the approximate time listed in Table 1. This is normally sufficient to remove absorbed moisture. Longer drying may be required where resistors have been stored for long periods of time under unusually high relative humidity.

TEST LIMITS AND PROCEDURES FOR HOT-MOLDED FIXED RESISTORS

TABLE 1

Resistor Type	Maximum Continuous Power Rating at +70°C Ambient (Except as Noted) Watts	Maximum Rated Continuous Working Voltage (RCWV) DC or RMS Volts	Dielectric Withstanding Voltage Volts At 30 in. Hg (1016 mbars) Sea Level	Dielectric Withstanding Voltage Volts At 3.4 in. Hg (115 mbars) 50,000 ft. (15240 meters)	Insulation Resistance Test Voltage Volts ±10%	Short-Time Overload Voltage Limit Volts	Recommended Conditioning Time at +100°C +5°C −0° Hours	Critical Resistance Value (See 3.1) Megohms
BB	1/8	150	300	200	100	200	25	0.18
CB	1/4	250	500	325	100	400	50	0.27
EB	1/2	350	700	450	500	700	75	0.27
GB	1	500	1000	625	500	1000	120	0.27
HB	2	750	1500	625	500	1000	130	0.30
GM	3	500	1000	625	500	1000	120	0.091
GM	4 at 40°C	500	1000	625	500	1000	120	0.068
HM	4	750	1500	625	500	1000	130	0.15
HM	5 at 40°C	750	1500	625	500	1000	130	0.12

TABLE 2

	Group 1
6.1	Visual and Mechanical Inspection
6.2	Resistance Tolerance
	Group 2
6.3	Resistance-Temperature Characteristic
6.4	Resistance-Voltage Coefficient
6.5	Dielectric Withstanding Voltage
6.6	Insulation Resistance
	Group 3
6.7	Low Temperature Operation
6.8	Thermal Shock
6.20	Low Temperature Storage
6.9	Moisture Resistance
6.10	Humidity (Steady State) — Alternate test for 6.9
6.11	Short Time Overload
	Group 4
6.12	Load Life
	Group 5
6.13	Terminal Strength
6.14	Resistance to Solder Heat
	Group 6
6.15	Solderability
	Group 7
6.16	Shock
6.17	Vibration
	Group 8
6.18	Pulse Applications
	Group 9
6.19	Color Code Solvent Resistance

TABLE 3

Temperature Characteristic Test Sequence (See 6.3)

Sequence	Ambient Temperature °C
A	+ 105
B	+ 85
C	+ 55
D	+ 25
E	0
F	− 25
G	− 55

TABLE 4

Thermal Shock Test Sequence (See 6.8)

Step	Temperature °C	Time Minutes
1	$-55\ ^{+0}_{-3}$	30
2	+25 ±5	5
3	$+85\ ^{+3}_{-0}$	30
4	+25 ±5	5

CROSS INDEX OF RESISTOR TEST METHODS FOR HOT-MOLDED FIXED RESISTORS

The table below lists the Allen-Bradley test methods used and equivalent or similar methods specified in military and industrial specifications with information to make the tests equivalent.

Test Description	Technical Publication EC5021-2.2 Paragraph Number	MIL-R-39008B Paragraph Number and Details	MIL-STD-202E Method and Details	EIA-RS-172-B Paragraph Number and Details
Resistance Measurements	5	**4.7.2** 1. Voltages per Paragraph 5.2	**303**	**3.2.2** 1. Voltages per Paragraph 5.2
Resistance — Temperature Characteristic	6.3	**4.7.3** 1. Temperatures per Table 3, Page 31 2. Omits recommendation for forced circulating air	**304** 1. Compute percent resistance difference per Paragraph 6.3.1	**3.2.3** 1. Temperatures per Table 3, Page 31 2. Omits recommendation for forced circulating air
Resistance — Voltage Coefficient	6.4	**4.7.4**	**309**	**3.2.4** 1. Voltage application should be momentary to minimize heating effects
Dielectric Withstanding Voltage	6.5	**4.7.5** 1. Test voltage to be 1500 volts for 2 watt per Table 1	**301** 1. Test duration 5 seconds. **105C** 1. Test Condition B. Test duration 5 seconds.	**3.2.5** 1. Test voltage to be 1500 volts for 2 watt per Table 1
Insulation Resistance	6.6	**4.7.6**	**302** 1. Test condition A (⅛ and ¼ watt) 2. Test condition B (½, 1 and 2 watt) *	No Equivalent Test
Low Temperature Operation	6.7	**4.7.7**	No Equivalent Test	**3.2.7**
Low Temperature Storage	6.20	**4.7.17**	No Equivalent Test	No Equivalent Test
Thermal Shock	6.8	**4.7.8**	**107D** 1. Test Condition A	**3.2.8** 1. Test sequence per Table 4
Moisture Resistance	6.9	**4.7.9**	**106D**	No Equivalent Test
Humidity (Steady State)	6.10	No Equivalent Test	**103B** 1. Test Condition A 2. Paragraph 3.1 not applicable	**3.2.9** 1. Post Conditioning per Paragraph 6.10.2
Short Time Overload	6.11	**4.7.10**	No Equivalent Test	**3.2.6**
Load Life	6.12	**4.7.15**	**108A** 1. Test Condition D, +70°C	**3.2.10**
Terminal Strength	6.13	**4.7.11**	**211A** 1. Test Condition A (⅛ watt) — 2 lbs. (0,91 kg); others 5 lbs. (2,27 kg). 2. Test Condition D	**3.2.11**
Resistance to Solder Heat	6.14	**4.7.12**	**210A** 1. Test Condition A for all styles except ⅛ watt shall be + 250°C ± 5°C.	**3.2.12**
Solderability	6.15	**4.7.16**	**208C**	**EIA-RS-178-B** 1. Test Condition 1
Shock	6.16	**4.7.13**	**213B** 1. Test Condition 1	No Equivalent Test
Vibration	6.17	**4.7.14**	**204C** 1. Test Condition D 2. Vibrate 6 hours in each of two planes per Paragraph 6.17.2	No Equivalent Test
Pulse Applications	6.18	**6.5**	No Equivalent Test	No Equivalent Test
Color Code Solvent Resistance	6.19	No Equivalent Test	**215** 1. Ultrasonic agitation in various solvents at + 40°C.	No Equivalent Test
Conditioning	7	**4.4.2** 1. Time and temperature per Page 30	No Equivalent Procedure	**3.1.3** 1. Time and Temperature per Page 30

Military Numbering System Fixed Resistors

MIL-R-11 (RC) RC07GF153K

RC07 Style/Power	GF Characteristic	153 Resistance Value	K Tolerance
(See Tables 1 and 2)	"G" = 70°C max. ambient temperature for full load operation. "F" = temperature coefficient which varies (with resistance) from ±625 ppm/°C to ±3100 ppm/°C.	First two digits are significant, 3rd digit "number of zeros." 153 = 15,000 Ohms	(See Table 4) K = ±10%

MIL-R-39008 (RCR) RCR07G153JS

RCR07 Style/Power	G Characteristic	153 Resistance Value	J Tolerance	S Failure Rate
(See Tables 1 and 2)	"G" indicates a max. ambient temperature of 70°C for full load operation, and a TC which varies (with resistance) from ±625 ppm/°C to ±1900 ppm/°C.	First two digits are significant, 3rd digit "number of zeros." 153 = 15,000 Ohms	(See Table 4) J = ± 5%	(See Table 5) S = .001% /1000 hours

MIL-R-10509 (RN) RN55D1003F

RN55 Style/Power	D Characteristic	1003 Resistance Value	F Tolerance
(See Tables 1 and 2)	(See Table 3) D = ±100 ppm/°C	First three digits are significant, 4th digit "number of zeros." 1003 = 100,000 Ohms	(See Table 4) F = ± 1%

MIL-R-55182 (RNR) RNR55H1003FS

RNR55 Style, Terminal and Power	H Characteristic	1003 Resistance Value	F Tolerance	S Failure Rate
(See Tables 1 and 2) RNR = Solderable Leads RNC = Solderable/Weldable Leads RNN = Nickel Leads	(See Table 3) H = ±50 ppm/°C	First three digits are significant, 4th digit "number of zeros." 1003 = 100,000 Ohms	(See Table 4) F = ±1%	(See Table 5) S = .001% /1000 hours

MIL-R-22684 (RL) RL07S153J

RL07 Style/Power	S Terminal (Lead)	153 Resistance Value	J Tolerance
(See Tables 1 and 2)	"S" = Solderable	First two digits are significant, 3rd digit "number of zeros." 153 = 15,000 Ohms	(See Table 4) J = ± 5%

MIL-R-39017 (RLR) RLR07C1502GR

RLR07 Style/Power	C Terminal (Lead)	1502 Resistance Value	G Tolerance	R Failure Rate
(See Tables 1 and 2)	"C" = Solderable/Weldable	First three digits are significant, 4th digit "number of zeros." 1502 = 15,000 Ohms	(See Table 4) G = ± 2%	(See Table 5) R = .01% /1000 hours

NOTE: The Established Reliability specification (i.e., MIL-R-39008, MIL-R-39017, and MIL-R-55182) supersede MIL-R-11, MIL-R-22684, and MIL-R-10509 respectively, for all *new* design. Resistors qualified to the three Established Reliability specifications may be substituted, without limitation, wherever the older MIL devices are specified.

TABLE 1 — Resistor Style

RC	Fixed Composition Resistor (MIL-R-11)
RCR	Fixed Composition Resistor, Established Reliability (MIL-R-39008)
RL	Fixed Film Resistor (MIL-R-22684)
RLR	Fixed Film Resistor, Established Reliability (MIL-R-39017)
RN	Fixed Resistor, High Stability (MIL-R-10509)
RNR	Fixed Film Resistor, Established Reliability (MIL-R-55182)

TABLE 2 — Resistor Power

Nominal Body Length x Dia. (in.)	Size	Power (at 70°C Unless Otherwise Stated)
RC - RCR - RL - RLR		
.145 x .062	05	1/8
.250 x .090	07	1/4
.375 x .138	20	1/2
.562 x .225	32	1
.688 x .138	42	2
RN (Characteristic C) - **RNR**		
.150 x .065	50	1/20 at 125°C
.250 x .109	55	1/10 at 125°C
.375 x .125	60	1/8 at 125°C
.625 x .188	65	1/4 at 125°C
.750 x .250	70	1/2 at 125°C
1.062 x .375	75	1 at 125°C
RN (Characteristic D)		
.250 x .109	55	1/8
.375 x .125	60	1/4
.625 x .188	65	1/2
.750 x .250	70	3/4

TABLE 3 — Characteristics

RN	
B	±500 ppm/°C
C	± 50 ppm/°C (T2)
D	±100 ppm/°C (T0, T1)
E	± 25 ppm/°C (T9)
F	± 50 ppm/°C
RNR/ RNC	
H	± 50 ppm/°C (T2)
J	± 25 ppm/°C (T9)
K	±100 ppm/°C (T0, T1)

NOTE: There is no temperature coefficient designation for the RL numbering system, all units are ±100 ppm/°C.

TABLE 4 — Tolerance

K	= ±10%
J	= ±5%
G	= ±2%
F	= ±1%
D	= ±0.5%
C	= ±0.25%
B	= ±0.10%

TABLE 5 — Failure Rate

1000 Hours (60 % Confidence)

M	= 1.0%
P	= 0.1%
R	= .01%
S	= .001%