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MILITARY STANDARD

RESISTORS, SELECTION AND USE OF

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DEPARTMENT OF DEFENSE
Washington, DC 20301

Resistors, Selection and Use of

MIL-STD-199D

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FOREWORD

This standard provides selected standard resistors for use in the design of military equipment.

The application information and performance characteristics contained in this standard are offered for guidance and are not to be considered as mandatory. Additional application information will be added when coordinated with the three military departments.

Additional sections of this standard will be developed as standard resistors of a given specification family are selected and coordinated with the three military departments.

CONTENTS

FIGURES

TABLES

SECTIONS

CROSS REFERENCE
(Specification number to section number)

1. SCOPE

1.1 Scope. This standard consists of the following:

a. Selected standard resistor types, detailed by sections, chosen jointly by the Departments of the Army, the Navy, and the Air Force for use in the design and manufacture of military equipment under the jurisdiction of the Departments.

b. Guides for the choice and application of resistors for use in military equipment.

Detailed requirements for resistors listed in this standard are covered in the applicable specification (see 2.1). When it has been determined that circuit requirements cannot be met by using resistor styles or characteristics listed in this standard, the design engineer shall, with the approval of the cognizant military activity, select from the applicable resistor specification styles or characteristics not listed herein.

1.2 Purpose of standard:

a. To provide the equipment designer with a selection of standard resistors for use in most military applications.

b. To control and minimize the variety of resistors used in military equipment in order to facilitate logistic support of equipment in the field.

c. To outline criteria pertaining to the use, choice, and application of resistors in military equipment.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications. The following specifications form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

MILITARY

	MIL-R-19	-	Resistor, Variable, Wirewound (Low Operating Temperature), General Specification For.
	MIL-R-22	-	Resistor, Variable (Wirewound, Power Type), General Specification For.
	MIL-R-26	-	Resistor, Fixed, Wirewound (Power Type), General Specification For.
	MIL-R-94	-	Resistor, Variable, Composition, General Specification For.
*	MIL-R-122	-	Resistor, Fixed, Precision, Established Reliability, General Specification For.
	MIL-R-12934	-	Resistor, Variable, Wirewound, Precision, General Specification For.
	MIL-R-18546	-	Resistor, Fixed, Wirewound (Power Type, Chassis Mounted), General Specification For.
	MIL-R-22097	-	Resistor, Variable, Non-Wirewound (Adjustment Type), General Specification For.
	MIL-R-22684	-	Resistor, Fixed, Film, Insulated, General Specification For.
*	MIL-R-23285	-	Resistor, Variable, Nonwire-wound, General Specification For.
	MIL-R-27208	-	Resistor, Variable, Wirewound (Adjustment Type), General Specification For.
	MIL-R-39002	-	Resistor, Variable, Wirewound, Semi-Precision, General Specification For.
	MIL-R-39005	-	Resistor, Fixed, Wirewound (Accurate), Established Reliability, General Specification For.
	MIL-R-39007	-	Resistor, Fixed, Wirewound (Power Type), Established Reliability, General Specification For.
	MIL-R-39008	-	Resistor, Fixed, Composition (Insulated), Established Reliability, General Specification For.
	MIL-R-39009	-	Resistor, Fixed, Wirewound (Power Type, Chassis Mounted), Established Reliability, General Specification For.
	MIL-R-39015	-	Resistor, Variable, Wirewound (Lead Screw Actuated), Established Reliability, General Specification For.
	MIL-R-39017	-	Resistor, Fixed, Film (Insulated), Established Reliability, General Specification For.

MIL-R-39023	-	Resistor, Variable, Non-Wirewound, Precision, General Specification For.
MIL-R-39035	-	Resistor, Variable, Non-Wirewound (Adjustment Type), Established Reliability, General Specification For.
MIL-R-55182	-	Resistor, Fixed, Film, Established Reliability, General Specification For.
MIL-R-55342	-	Resistor, Fixed, Film, Chip, Established Reliability, General Specification For.
MIL-R-83401	-	Resistor Networks, Fixed, Film, General Specification For.
MIL-T-23648	-	Thermistor (Thermally Sensitive Resistor) Insulated, General Specification For.

(Copies of specifications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Rating and design application terms. A list of common terms used in rating and design application of resistors is as follows:

a. Ambient operating temperature. The temperature of the air surrounding an object, neglecting small localized variations.

b. Contact resistance variation. The apparent resistance seen between the wiper and the resistance element when the wiper is energized with a specified current and moved over the adjustment travel in either direction at a constant speed. The output variations are measured over a specified frequency bandwidth, exclusive of the effects due to roll-on or roll-off of the terminations and is expressed in ohms or percent of total nominal resistance.

c. Critical value of resistance. For a given voltage rating and a given power rating, there is only one value of resistance that will dissipate full rated power at rated voltage. This value of resistance is commonly referred to as the "critical value of resistance." For values of resistance below the critical value, the maximum (element) voltage is never reached and, for values of resistance above critical value, the power dissipated becomes lower than rated. Figure 1 shows this relationship.

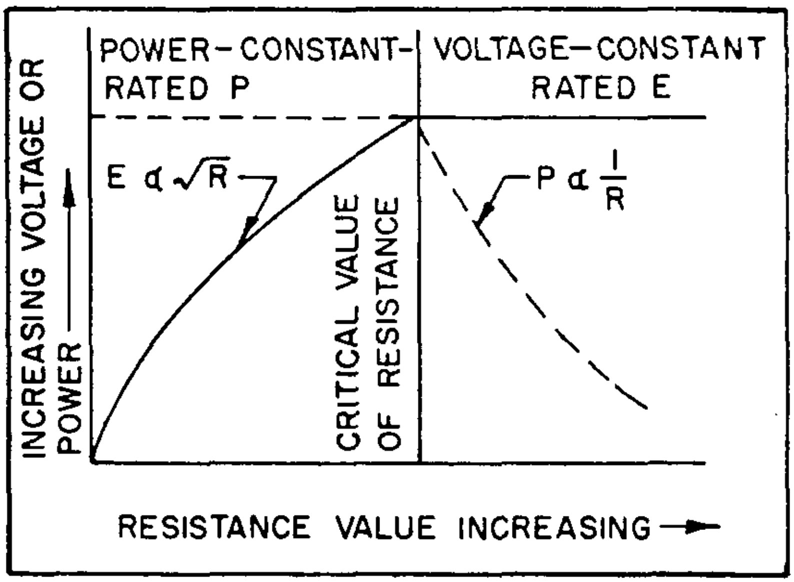


FIGURE 1. Maximum working voltage and critical value of resistance.

d. Dielectric strength. The ultimate breakdown voltage of the dielectric or insulation of the resistor when the voltage is applied between the case and all terminals tied together. Dielectric strength is usually specified at sea level and simulated high altitude air pressures.

e. Hot-spot temperature. As defined in military specifications, the maximum temperature measured on the resistor due to both internal heating and the ambient operating temperature. Maximum hot-spot temperature is predicated on thermal limits of the materials and the design. The hot-spot temperature is also usually established as the top temperature on the derating curve at which the resistor is derated to zero power.

f. Insulation resistance. The dc resistance measured between all terminals connected together and the case, exterior insulation, or external hardware.

g. Maximum (element) working voltage ($E = \sqrt{PR}$). The maximum voltage stress (dc or rms) that may be applied to the resistor (resistance element) is a function of (1) the materials used, (2) the required performance, and (3) the physical dimensions. (See figure 1.)

h. Noise. An unwanted voltage fluctuation generated within the resistor. Total noise of a resistor always includes Johnson noise 1/ which is dependent only on the resistance value and temperature of the resistance element. Depending on the type of element and construction, total noise may also include noise caused by current flow, and noise caused by cracked bodies and loose end caps or leads. For variable resistors, noise may also be caused by jumping of contact over turns of wire and by an imperfect electrical path between the contact and resistance element.

i. Resistance temperature characteristic (temperature coefficient). The magnitude of change in resistance due to temperature, usually expressed in percent per degree Celsius or parts per million per degree Celsius (ppm/°C). If the changes are linear over the operating temperature range, the parameter is known as "temperature coefficient."

j. Resistance tolerance. The permissible deviation of the manufactured resistance value (expressed in percent) from the specified nominal resistance value at standard (or stated) environmental conditions.

k. Stability. The overall ability of a resistor to maintain its initial resistance value over extended periods of time when subjected to any combination of environmental conditions and electrical stresses.

1/ Johnson, J. B., "Thermal Agitation of Electricity in Conductors," Physical Review, Volume 32 (July, 1928, 97-109).

4. GENERAL REQUIREMENTS

4.1 Choice of resistor types. The variety of resistor types used in any particular equipment shall be the minimum necessary to obtain satisfactory performance. Where more than one type of resistor may be used in a given application (i.e., fixed, film, insulated versus fixed, film, insulated (high stability)), consideration should be given to cost and availability (use of strategic materials, multiple sources, etc.). The resistors identified in this standard meet all the criteria for standard types (see 1.1 and 4.4).

4.1.1 Reliability. Where quantitative reliability requirements specified as part of the equipment requirements are such that the use of parts with established reliability is dictated, such parts shall be selected from the established reliability sections (300 and 400) of this standard.

4.1.2 Qualified sources. After a preliminary selection of the desired resistor has been made, reference should be made to the applicable qualified products list for listing of qualified sources.

4.2 Item identification. A type designation for any resistor referenced herein may be constructed as indicated in the example given in the applicable section. The part number assignments, where applicable, are as specified in the section.

4.3 Conflict of requirements. In the event of conflict between technical requirements of resistors described in this standard and the applicable specification, the specification shall govern; however, this standard will be up-dated concurrently to reflect specification changes.

4.4 Criteria for inclusion in this standard. The criteria for the inclusion of resistor types in this standard are as follows:

a. The resistor shall be the best type available for general use in military equipment.

b. Coordinated military specifications shall be available (see 2.1).

c. Resistors shall be in or shall have been in production.

d. Where possible, the resistor shall remain in the section for a minimum of 1 year.

5. DETAILED REQUIREMENTS

5.1 The detailed requirements for standard resistor types are contained in the applicable specification and the applicable section of this standard.

6. NOTES

6.1 Intended uses. General application notes are as indicated in the appendix.

6.2 Subject term (key word) listing.

Chip
Film
Lead-screw
Network
Non-wirewound
Resistance-temperature characteristic
Resistor
Thermistor
Variable
Varistor
Wirewound

6.3 Changes from previous issue. The margins of this standard are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

APPENDIX

GENERAL APPLICATION INFORMATION

* 10. GENERAL

10.1 Scope. The application information in this standard is designed to help the engineer select the resistors he will specify (application information pertaining to specific resistor types is contained in the applicable sections). As with other types of components, the most important thing a user must decide is which of the numerous types of resistors will be best for use in the military equipment he is designing. Proper selection in its broadest sense is the first step in building reliable equipment. To properly select the resistors to be used, the user must know as much as possible about the types from which he can choose. He should know their advantages and disadvantages, their behavior under various environmental conditions, their construction, and their effect on circuits and the effect of circuits on them. He should know what makes resistors fail. He should also have an intimate working knowledge of the applicable military specification. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

10.1.1 Resistor types. All variable and fixed resistors, of the types widely used in electronic equipment, can be grouped into one of three general basic types. They are "composition" types, "film" types, or "wirewound" types. As the name indicates, the "composition" type is made of a mixture of resistive material and a binder which are molded into the proper shape and resistance value. The "film" type is composed of a resistive film deposited on, or inside of, an insulating cylinder or filament. The "wirewound" type is made up of resistance wire, wound on an insulated form. These basic types differ from each other in size, cost, resistance range, power rating, and general characteristics. Some are better than others for particular purposes; no one type has all of the best characteristics. The choice among them, therefore, depends on the requirements, both initial and long-term; the environment in which they must exist; and numerous other factors which the designer must understand. The designer must realize that the summaries of the following general characteristics are relative, not absolute, and that all the requirements of a particular application must be taken into consideration and compared with the advantages and drawbacks of each of the several types, before a final choice is made. Tables I, II, and III 2/ provide a selection guide for fixed and variable resistors included in this standard.

The military resistor specification categories are shown on figure 2.

10.2 Principal applications:

a. MIL-R-19, RA, variable, wirewound (low operating temperature). Use primarily for noncritical, low power, low frequency applications where characteristics of wirewound resistors are more desirable than those of composition resistors.

b. MIL-R-22, RP, variable wirewound (power type). Use in such applications as motor speed control, generator field control, lamp dimming, heater and oven control, potentiometer uses, and applications where variations of voltage and current are expected.

c. MIL-R-26, RW, fixed, wirewound (power type). Use where large power dissipation is required and where ac performance is relatively unimportant (i.e., when used as voltage divider or bleeder resistors in dc power supplies, or for series dropping). They are generally satisfactory for use at frequencies up to 20 kilohertz (kHz) even though the ac characteristics are controlled. Neither the wattage rating nor the rated continuous working voltage may be exceeded.

d. MIL-R-94, RV, variable, composition. Use where initial setting stability is not critical and long-term stability needs to be no better than ±20 percent.

2/ See tables on pages 21 through 27.

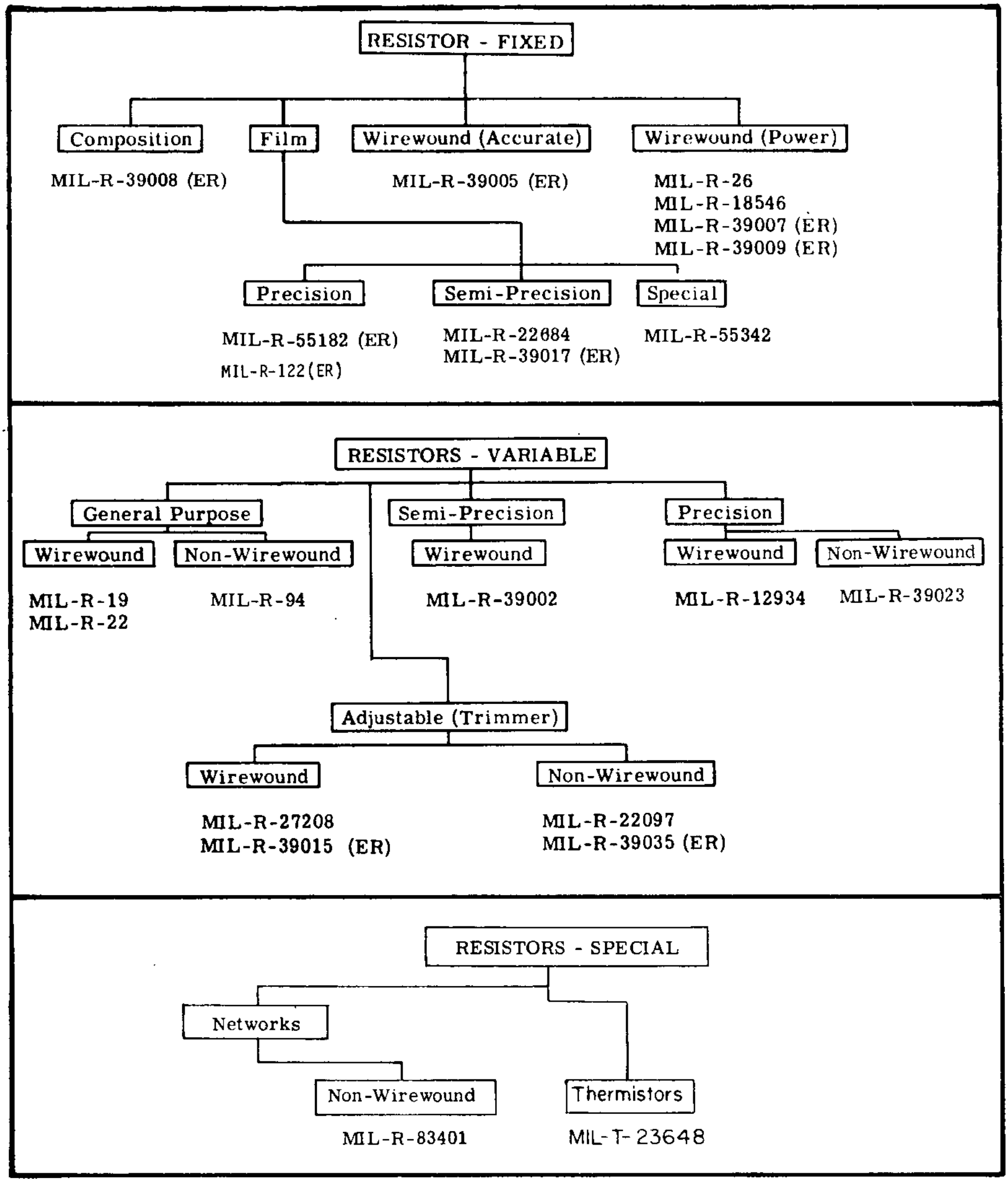


FIGURE 2. Military resistor specification categories.

e. MIL-R-122, RFP, fixed, film, established reliability. Use in circuits requiring higher stability than provided by composition resistors or film, insulated, resistors and where ac frequency requirements are critical. Operation is satisfactory from dc to 100 megahertz (MHz). Metal films are characterized by low temperature coefficients and are usable for ambient temperatures of 125°C or higher with small degradation. High precision, lower RTC than MIL-R-55182.

f. MIL-R-12934, RR, variable, wirewound (precision). Use in servo-mounting applications requiring precise electrical and mechanical output and performance. Used in computer, antenna, flight control, and bomb navigation systems, etc.

g. MIL-R-18546, RE, fixed, wirewound (power type, chassis mounted). Use where power tolerance and relatively large power dissipation is required for a given unit size than is provided by MIL-R-26 resistors, and where ac performance is noncritical (i.e., voltage divider or bleeder resistors in dc power supplies or series-dropping circuits).

h. MIL-R-22097, RJ, variable non-wirewound (adjustment type). Use for matching, balancing, and adjusting circuit variables in computers, telemetering equipment, and other critical applications.

i. MIL-R-22684, RL42...TX, fixed, film, insulated. These film resistors have semi-precision characteristics and small sizes. The sizes and wattage ratings are comparable to those of MIL-R-39008 and stability is between MIL-R-39008 and MIL-R-55182. Design parameter tolerances are looser than those of MIL-R-55182 but good stability makes them desirable in most electronic circuits. See MIL-R-39017.

j. MIL-R-23285, RVC, variable, metal film, non-wirewound. Use where initial setting stability is not critical and long-term stability needs to be no better than +5 percent. RVC resistors have low noise and long life characteristics.

k. MIL-R-27208, RT, variable, wirewound (adjustment type). Use for matching, balancing, and adjusting circuit variables in computers, telemetering equipment, and other critical applications.

l. MIL-R-39002, RK, variable, wirewound, semi-precision. See MIL-R-27208.

m. MIL-R-39005, RBR, fixed, wirewound (accurate). Use in circuits requiring higher stability than provided by composition or film resistors, and where ac frequency performance is not critical. Operation is satisfactory from dc to 50 kHz. Replaces MIL-R-93, RB (wirewound (accurate)).

n. MIL-R-39007, RWR, fixed, wirewound (power type). See MIL-R-26.

o. MIL-R-39008, RCR, fixed, composition (insulated). Use insulated resistors for general purpose resistor applications where the initial tolerance needs to be no closer than +5 percent and long term stability needs to be no better than +15 percent under fully rated operating conditions. Replaces MIL-R-11, RC (fixed, composition (insulated)).

p. MIL-R-39009, RER, fixed, wirewound (power type, chassis mounted). Use where power tolerance and relatively large power dissipation is required for a given unit size than is provided by MIL-R-39007 resistors, and where ac performance is noncritical (i.e., voltage divider or bleeder resistors in dc power supplies or series-dropping circuits).

q. MIL-R-39015, RTR, variable, wirewound (lead screw actuated). See MIL-R-27208.

r. MIL-R-39017, RLR, fixed, film (insulated). These film resistors have semi-precision characteristics and small sizes. The sizes and wattage ratings are comparable to those of MIL-R-39008 and stability is between MIL-R-39008 and MIL-R-55182. Design parameter tolerances are looser than those of MIL-R-55182 but good stability makes them desirable in most electronic circuits. Replaces MIL-R-22684, RL (fixed film (insulated)).

s. MIL-R-39023, RQ, variable, non-wirewound (precision). Use in servo mounting applications requiring precise electrical and mechanical output and performance. Used in computer, antenna, flight control, and bomb navigation systems, etc.

t. MIL-R-39035, RJR, variable, non-wirewound (adjustment type). Use for matching, balancing, and adjusting circuit variables in computers, telemetering equipment, and other critical applications.

u. MIL-R-55182, RNR, fixed, film (high stability). Use in circuits requiring higher stability than provided by composition resistors or film, insulated, resistors and where ac frequency requirements are critical. Operation is satisfactory from dc to 100 megahertz (MHz). Metal films are characterized by low temperature coefficients and are usable for ambient temperatures of 125°C or higher with small degradation. Replaces MIL-R-10509, RN (fixed, film (high stability)).

v. MIL-R-55342, RM, chip, fixed, film. These chip resistors are primarily intended for incorporation into hybrid microelectronic circuits. They are designed for use in critical circuitry where stability, long life, reliable operation, and accuracy are of prime importance.

w. MIL-R-83401, RZ, network, fixed, film. These networks are designed for use in critical circuitry where stability, long life, reliable operation, and accuracy are of prime importance. They are particularly desirable for use where miniaturization is important and ease of assembly is desired. They are useful where a number of resistors of the same resistance value are required in the circuit.

x. MIL-T-23648, Thermistor (thermally sensitive resistor) insulated. These resistors exhibit a rapid change in resistance for a relative small temperature change. These resistors are used to measure temperature or to compensate for changes in temperature.

20. REFERENCED DOCUMENTS

Not applicable.

30. GENERAL CHARACTERISTICS OF RESISTORS

30.1 General characteristics of fixed resistors.

30.1.1 Fixed, composition resistors, RCR.

a. Nominal minimum resistance tolerance available for fixed, composition resistors is ±5 percent. Combined effects of climate and operation on unsealed types may raise this tolerance to ±15 percent from the low value (i.e., aging, pressure, temperature, humidity, voltage gradient, etc.).

b. High-voltage gradients will produce resistance change during operation.

c. High "Johnson" noise levels at resistances above 1 megohm preclude use in critical circuits of higher sensitivity.

d. RF will produce end-to-end shunted capacitive effects because of short resistor bodies and small internal distances between both ends.

e. Operation at VHF or higher frequency reduces effective resistance due to losses in the dielectric (the so-called "Boella" effect).

f. Exposure to humidity may have two effects on the resistance value: Surface moisture may result in leakage paths which will lower the resistance values or absorption of moisture into the element may increase the resistance. This phenomenon is more noticeable in higher ranges since it depends upon the resistance value.

g. The resistance temperature characteristic is the highest for general purpose resistor styles covered by military specifications.

30.1.2 Fixed, film resistors, RNR, RLR, and RL; fixed, film networks, RZ; and fixed, film chips, RM.

a. Low tolerance; high stability; low environmental changes; low temperature coefficient; spacing and weight saving; low noise.

b. Nominal minimum resistance tolerance available is +0.1 percent for fixed, film resistors; and for the resistor networks, the nominal minimum resistance tolerance available is +1.0 percent.

c. Maximum practical full-power operating temperature should not exceed 125°C for metal film RNR types; types RLR and RL resistors conform to the 70°C rating. Type RZ resistor networks and type RM resistor chips are continuously derated from 70°C to 125°C.

d. Operation at RF (above 100 MHz) may produce inductive effects on spiral-cut type fixed, film resistors, and capacitive effects on the resistor networks.

e. The resistance temperature characteristic is fairly low (+500 ppm/°C and +200 ppm/°C) for thick film types (RL and RLR) and very low (+25 ppm/°C) for metal film type (RNR); the resistance temperature characteristic is fairly low (+300 ppm/°C, +100 ppm/°C and +50 ppm/°C) for resistor networks (RZ) and resistor chips (RM).

30.1.3 Fixed, wirewound (accurate) resistors, RBR.

a. Fixed, wirewound, accurate resistors are physically the largest of all types for a given resistance and power rating, since they are very conservatively rated and are available in standard tolerances as low as +0.1 percent.

b. Because of the general method of construction (employing a plastic or ceramic bobbin), this type is subject to mechanical damage resulting from vibration, shock, and pressure.

c. Used where high cost and size are not important and operational climate can be controlled.

d. Application of voltages in excess of voltage rating may cause insulation breakdown in the thin coating of insulation between element coatings.

e. Operation above 50 kHz may produce inductive effects and intrawinding capacitive effects.

f. Resistance element is quite stable within specified temperature limits.

g. Use of good soldering techniques is extremely important, since higher contact resistance may cause overall resistance shifts far outside of resistance tolerance on low value units.

h. The presence of moisture may degrade coating or potting compounds.

30.1.4 Fixed, wirewound resistors (power type), RER, RE, RW, and RWR.

a. This type resistor is generally not supplied in low tolerances, since most applications of this type do not require accurate resistance.

b. The use of tapped resistors is to be avoided, because insertion of taps weakens the resistor mechanically, and lowers the effective power rating.

30.2 General characteristics of variable resistors:

a. All types of variable resistors should be derated for operation above their rated ambient temperature.

b. Wirewound types should not be used in frequency-sensitive RF circuits due to introduction of inductive and capacitive effects.

c. High humidity conditions may have a deleterious effect on unenclosed types due to resistance shift in composition types and winding-to-winding shorts in wirewound types.

d. Composition elements may wear away after extended use, leaving particles of the element to permeate the mechanism, resulting in warmer operation, high-resistance shorts, etc. Wirewound types are subject to noise because of stepping of the contact from wire to wire.

e. With either wirewound or non-wirewound resistors, good practice indicates the use of enclosed units to keep out as much dust and dirt as possible and to protect the mechanism from mechanical damage. The presence of oil through lubrication may cause dust or wear particles present to concentrate within the unit.

f. Since the resistance is variable, it is necessary to provide some method of preventing movement of the wiper arm, other than those movements required during operation. For resistors which are not in continuous use, the short locked shaft with a slotted end is preferred. For continuous use, the high torque shaft will limit the amount of motion due to shock, vibration, and accidental movement. Where it is absolutely necessary to have a long shaft, a coupled extension is preferred to one long integral shaft. Regardless of the type of shaft, the use of oversize control knobs which permit high rotational torque will generally result in damage to the integral stop. Use the smallest size knob to reduce torque.

g. When choosing a resistor, take care to ensure that the power rating of the unit will be sufficient to handle the higher current produced when the resistance is reduced, particularly if being used in series as a voltage dropping resistor.

h. When a variable linear resistor is being used as a voltage divider, the output voltage through the wiper will not vary linearly if current is being drawn through it. This characteristic is usually called the "loading error." To reduce the loading error, the load resistance should be at least 10 to 100 times as great as the end-to-end potentiometer resistance.

i. Lead screw actuated variable resistors can provide a high degree of accuracy in critical adjustments; however, the user should consider the effects of backlash in the lead screw position versus wiper position. The resistance obtained at an initial setting may change slightly under conditions of vibration and shock as the wiper settles into a new position. The magnitude of this change is allowed to be as high as 1 percent when new, and can increase with age up to about 3 percent or the equivalent of one-half turn of the lead screw. In extremely critical applications, it may be desirable to decrease the resistance value of the variable resistor, and add a suitable fixed resistance in series to obtain the same overall resistance, thus giving less critical adjustments but with a decrease in the adjustable range.

30.3 Mounting guide.

30.3.1 Stress mounting. Improper heat dissipation is the predominant contributing cause of failure for any resistor type; consequently, the lowest possible resistor surface temperature should be maintained. Figure 3 illustrates the manner in which heat is dissipated from fixed resistors in free air. The intensity of radiated heat varies inversely with the square of the distance from the resistor. Maintaining maximum distance between heat-generating components serves to reduce cross-radiation heating effects and promotes better convection by increasing air flow. For optimum cooling without a heat sink, small resistors should have large diameter leads of minimum length terminating in tiepoints of sufficient mass to act as heat sinks. All resistors have a maximum surface temperature which should never be exceeded. Any temperature beyond maximum can cause the resistor to malfunction. Resistors should be mounted so that there are no abnormal hot spots on the resistor surface. When mounted, resistors should not come in contact with heat-insulating surfaces.

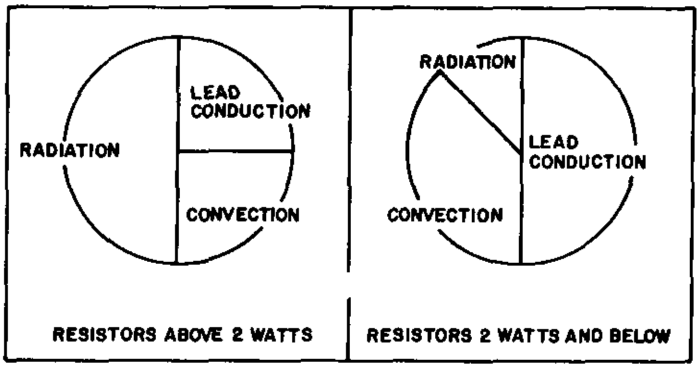


FIGURE 3. Heat dissipation of resistors under room conditions.

30.3.2 Resistor mounting for vibration. Resistors should be mounted so resonance does not occur within the frequency spectrum of the vibration environment to which the resistors may be subjected. Some of the most common resistor packaging methods result in large resistor noise. Resistor mounting for vibration should provide (1) the least tension or compression between the lead and body, (2) the least excitation of the resistor in relation with any other surface, and (3) no bending or distortion of the resistor body.

30.3.3 Circuit packaging. Resistors that are crowded together and come into contact with each other can provide leakage paths (even well insulated parts) for external current passage. This can change the resultant resistance in the circuit. Moisture traps and dirt traps are easily formed by crowding. Moisture and dirt eventually form corrosive materials which can deteriorate the resistors and other electronic parts. Moisture can accumulate around dirt even in an atmosphere of normal humidity. Planning should be done to eliminate crowding of parts. Proper space utilization of electronic parts can reduce the package size and still provide adequate spacing of parts.

30.3.4 Summary. The following is a guide for resistor mounting:

a. Maintain lead length to a minimum. The mass of the point acts as a heat sink. (NOTE: Where low temperatures are present, leads should be offset (bent slightly) to allow for thermal contraction.)

b. Close tolerance and low-value resistors require special precautions (i.e., short leads and good soldering techniques) since the resistance of the leads and the wiring may be as much as several precent of the resistance of the resistor.

c. Maintain maximum spacing between resistors.

d. For resistors mounted in series, consider the heat being conducted through the leads to the next resistor.

e. Large power units should be mounted to the chassis.

f. Do not mount high-power units directly on terminal boards or printed circuits.

g. To provide for the most efficient operation and even heat distribution, power resistors should be mounted in a horizontal position.

h. Select mounting materials that will not char and can withstand strain due to expansion.

i. Consider proximity to other heat sources as well as self heat.

j. Consider levels of shock and vibration to be encountered. Where large body mass is present, the body should be restrained from movement.

30.4 Effects of circuit usage. Resistors must be selected to be compatible with the conditions to which they are exposed. Numerous matters must be considered in this selection process. The most important are noted in the following.

30.4.1 Resistance value. This is initially determined by the circuit requirements, and may seem a trivial thing to mention. However, most resistor calculations that are made without reference to available resistors come out to a resistance value that is not standard. The design engineer should be aware of the standard resistance values that are available from manufacturers who adhere to this standard and various military specifications for resistors. These differ somewhat with the various types of resistors. It is usually a fairly simple thing to bring the exact calculated value in line with a standard value. In the case where this cannot be done, a parallel or series combination of resistors can usually be used. The design engineer should also remember that the resistance value of the resistor that gets into the physical circuit will differ from the value he has stated on his circuit schematic, and that this difference will change as time goes by. The purchase tolerance of the resistor to be used will allow it to differ from the nominal stated value, depending on the type of resistor specified. Furthermore, the temperature at which the resistor works, the voltage across it, and the environment in which it lives will affect the actual value at particular times. For example, the designer should allow for a possible variation of ±15 percent from the nominal value of a purchased ±5 percent composition resistor, if he expects his circuit to continue to operate satisfactorily over a very long time under moderate ambient conditions. Such a figure is a rule of thumb, based on many tests, and many resistors will remain much nearer their starting value; but if many are used, chance will ensure that some will go near this limit. A similar figure can be deduced from each variety of resistor used.

30.4.1.1 Summary.

a. Select a resistor for each circuit application from the lists of standard types and values.

b. Be sure that the circuit being designed will work with any resistor whose resistance value is within the limits set by tolerance plus voltage coefficient plus temperature coefficient plus drift with time. Failure to take these precautions can possibly mean that in equipment produced in quantity for the armed services, there may be some circuits that will not work under extreme conditions.

c. Various initial tolerances are available depending on the type of resistor. It should be remembered that initial accuracies become meaningless if the inherent stability of the resistor does not support the initial accuracy.

d. During shelf life, as well as during operational life, any characteristic (i.e., resistance, inductance, power rating, dielectric strength, size, etc.)of any part may change value due to stresses caused by environmental changes of temperature, humidity, pressure, vibration, etc. Changes of character- istic caused by environmental stresses may be linear or nonlinear, reversible or nonreversible (permanent), or combinations thereof. Where a character- istic of the part undergoes a linear change during environmental stress, and the change reverses itself linearly when the environmental stress is removed so that the characteristic returns to its normal value, this rate of change in characteristic value (per unit change in stress value) is designated (x) coefficient, and is usually expressed in percent or ppm/°C.

30.4.2 Power rating. The minimum required power rating of a resistor is another factor that is initially set by the circuit usage, but is markedly affected by other conditions of use. As mentioned previously, the power rating is based on the hot-spot temperature the resistor will withstand, while still meeting its other requirements of resistance variation, accuracy, and life.

30.4.2.1 Self-generated heat. Self-generated heat in a resistor is, of course, calculated as $P = I^2R$. This figure, in any circuit, must be less than the actual power rating of the resistor used. It is the usual practice to calculate this value and to use the next larger power rating available in the standard. This calculation should, however, be considered only as a first approximation of the actual rating to be used.

30.4.2.2 Rating versus ambient conditions. The power rating of a resistor is based on a certain temperature rise from an ambient temperature of a certain value. If the ambient temperature is greater than this value, the amount of heat that the resistor can dissipate is correspondingly reduced, and therefore it must be derated because of temperature. The applicable section of this standard and all of the military specifications contain derating curves to be applied to the resistors covered.

30.4.2.3 Rating versus accuracy. Because of the temperature coefficient of resistance that all resistors possess, a resistor which is expected to remain near its measured value under conditions of operation must remain cool. For this reason, all resistors designated as "accurate" are very much larger physically for a certain power rating than are ordinary "nonaccurate" resistors. In general, any resistor, "accurate" or not, must be derated to remain very near its original measured value when it is being operated.

30.4.2.4 Rating versus life. If especially long life is required of a resistor, particularly when "life" means remaining within a certain limit of resistance drift, it is usually necessary to derate the resistor, even if ambient conditions are moderate and if accuracy by itself is not important. A good rule to follow when choosing a resistor size for equipment that must operate for many thousands of hours is to derate it to one half of its nominal power rating. Thus, if the self-generated heat in the resistor is 1/3 watt, do not use a 1/2-watt resistor, but rather a 1-watt size. This will automatically keep the resistor cooler, will reduce the long-term drift, and will reduce the effect of the temperature coefficient. In equipment that need not live so long and must be small in size, this rule may be impractical, and the engineer should adjust his dependence on rules to the circumstances at hand. A "cool" resistor will generally last longer than a "hot" one, and can absorb transient overloads that might permanently damage a "hot" resistor.

30.4.2.5 Rating under pulsed conditions and under intermittent loads. When a resistor is used in circuits where power is drawn intermittently or in pulses, the actual power dissipated with safety during the pulses can sometimes be much more than the maximum rating of the resistor. For short pulses, the actual heating is determined by the duty factor and the peak power dissipated. Before approving such a resistor application, however, the engineer should be sure (1) that the maximum voltage applied to the resistor during the pulses is never greater than the permissible maximum voltage for the resistor being used, (2) that the circuit cannot fail in such a way that continuous excessive power can be drawn through the resistor and cause it to fail also, (3) that the average power being drawn is well within the agreed-on rating of the resistor, and (4) that continuous steep wavefronts applied to the resistor do not cause any unexpected troubles.

30.4.3 High frequency. For most resistors the lower the resistance value, the less total impedance it exhibits at high frequency. Resistors are not generally tested for total impedance at frequencies above 120 hertz. Therefore, this characteristic is not controlled. The dominating conditions for good high-frequency resistor performance are geometric considerations and minimum dielectric losses. For the best high-frequency performance, the ratio of resistor length to the cross sectional area should be a maximum. Dielectric losses are kept low by proper choice of the resistor base material, and when dielectric binders are used, their total mass is kept to a minimum. The following is a discussion of the high-frequency merits of these major resistor types:

a. Carbon composition. This type exhibits little change in effective dc resistance up to frequencies of about 100 kHz. Resistance values above .3 megohm start to decrease in resistance at approximately 100 kHz. Above frequencies of 1 MHz, all resistance values exhibit decreased resistance.

b. Wirewound. Wirewound resistors have inductive and capacitive effects and are unsuited for use above 50 kHz, even when specially wound to reduce the inductance and capacitance. Wirewound resistors usually exhibit an increase in resistance with high frequencies because of "skin" effect.

c. Film type. Film-type resistors have the best high-frequency performance. The effective dc resistance for most resistance values remains fairly constant up to 100 MHz and decreases at higher frequencies. In general, the higher the resistance value the greater the effect of frequency.

30.5 Effects of mechanical design and ambient conditions. Since the operation of a circuit cannot be divorced from the physical configuration it assumes when assembled, some of the points that apply herein have already been discussed. It is well, however, to check this aspect of equipment design several times, so redundancies in the following paragraphs are deliberate for the sake of emphasis.

30.5.1 Mechanical design of resistors. Much trouble during the life of the equipment can be eliminated if the design engineer can be sure that the resistors he is specifying for his circuits are soundly constructed and proper equipment assembly techniques are utilized. The resistor types listed in this standard provide a great measure of this assurance and, in general, assure a uniform quality of workmanship. The areas detailed in 30.5.1.1 through 30.5.1.6 are included as indicators of sound product construction.

30.5.1.1 End-caps or terminations. The connection between the resistor element itself and the pigtails or leads that connect it into the circuit must be so good that no possible combination of conditions met in the proposed service can cause an intermittent connection. The military specifications cover this point, and provide tests to check for it. When resistors are handled in automatic assembly machines, this precaution is particularly important.

30.5.1.2 Effect of soldering. There are assembly techniques that affect resistor reliability. Resistors should never be overheated by excessive soldering-iron applications, and the resistor leads should not be abraded by assembly tools. No normal soldering practice, either manual or dip soldering, should damage the resistor physically or change its resistance value appreciably.

30.5.1.3 Moisture resistance. Moisture is the greatest enemy of components and electronic equipment. Usually a resistor will keep itself dry because of its own self-generated heat; this is, of course, only true when the equipment is turned on. If the equipment must stand for long periods under humid conditions without power applied, the engineer should determine whether his circuits will operate with resistance values which have changed from the "hot" condition, and whether the retrace of the resistance value during the warmup period will allow the equipment to work satisfactorily during this period. If it will not, he must see that a resistor adequately protected against moisture absorption is used. The resistor cannot be blamed for performing improperly if it is not designed for the use to which it is put. It is therefore up to the design engineer to analyze what is needed and to provide the resistor to meet these conditions. This standard and the applicable military specifications constitute a guide as to what various kinds of resistors will do under humid conditions.

30.5.1.4 Method of mounting. Large resistors that are not provided with some adequate means of mounting should not be considered. Under conditions of vibration or shock, lead failure can occur, and the larger the mass supported by the leads the more probable a failure will be. Even when vibration or shock will not be a serious problem, ease of assembly and replaceability suggest that large components be mounted individually.

30.5.1.5 Resistor body. The body of the resistor must be sufficiently strong to withstand any handling it is likely to get. The specifications call out, through workmanship and packaging requirements, that it be shown by the manufacturer that his product will not crack, chip, or break in transit, on the shelf, or in the normal assembly process.

30.5.1.6 Insulation or coating. All resistors intended for use in reliable electronic equipment must be protected by an insulating coating. Sometimes this is a molded phenolic case, epoxy coating, or ceramic or glass sleeves. Wirewound power resistors use various cement and vitreous enamel coatings to protect the windings, and to insulate and provide moisture barriers. Not all of the coatings and insulations applied to commercial resistors are satisfactory for extreme variations in ambient conditions; the various military specifications include tests used to qualify the various manufacturers' products thus providing a greater confidence in the coating used.

30.5.2 Effects of ambient conditions. In the establishment of ratings for resistors, the design engineer has implicitly considered the mechanical design of the equipment. This may not have been realized, but it is so because the ambient conditions in which the resistor must operate determine to a large degree the power rating and mechanical construction of the resistor if long life -- or any life, under extreme conditions -- is desired.

30.5.2.1 Resistor heating. A very important question in the application of resistors is how hot will they get in service. In a piece of equipment the heat in a resistor comes from several sources; namely, (1) self-generated heat, and is the thing that can be easily calculated, and (2) the heat that the resistor receives from other resistors or other heat-producing components in the same immediate neighborhood by radiation, and is not so easily calculated. The important thing to remember is that under these conditions each resistor will be heated more than I^2R would suggest; when much heat is produced, as in stacked wirewound resistors, the design engineer would do well not to freeze his design until he has measured a typical assembly with power on to see just how hot the resistors get. The same thing is true of the extra heating given the resistors by convection. This is another way of saying that high-ambient temperature will reduce the actual power rating of the resistor by reducing permissible temperature rise, a point that has been made several times before. The equipment designer must realize also that the heat being produced by "hot" resistors can injure other components. This is a very important point to remember; capacitors, diodes, and other resistors usually do not fail immediately when overheated. The effect of too much heat is a deteriorating one, weakening the component until at a later date it will unexpectedly fail. It is very easy to put a "heat bomb" in a piece of equipment that will not go off in normal production testing but will do so when the equipment gets into service and is being relied on to do its duty. It is also very easy to eliminate such troubles by strict and thoughtful attention to the problem of heating. A few rules have been given for use as guides to protect against these factors (see 30.3).

30.5.2.2 High altitude. With the exception of the dielectric withstanding voltage test at reduced barometric pressure, all tests in military specifications referenced herein are performed at ambient atmospheric pressure. This fact should be considered when the use of these resistors for high-altitude conditions is contemplated.

30.5.2.3 Flammability. It should be noted that military specifications referenced herein contain no requirements concerning the flammability of the materials used in the construction of these resistors. Users should take this into consideration when a particular application involves this requirement.

40. SUPPLEMENTAL INFORMATION

40.1 Reliability. The established reliability specification provides for the establishment of a failure rate figure through the single parameter of load life only. Although, in most instances, the established reliability specification provides for more frequent moisture resistance, burn in, and other types of screening tests on a 100-percent basis, the failure rate figure (in percent per 1,000 hours) is based only on load life test results.

40.2 Metric equivalents. The metric equivalents (to the nearest .01 mm) which are provided in the individual sections are for general information only and are based upon 1 inch = 25.4 mm.

40.3 International standardization agreements. Certain provisions of the specifications referenced in this standard are the subject of international standardization agreements (see table IV). When amendment, revision, or cancellation of any of these specifications is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

TABLE I. Fixed resistor selection guidance table.

Section	Type	Styles available in standard	Power and max voltage ratings	Resistance tolerance (± percent)	Ohmic range	Temperature range (°C) 1/	Resistance temperature coefficient (ppm/°C)	Max body size (inches)	Configuration (see fig. 4)
101 (MIL-R-26)	Wirewound (Power Type)	RW29	11 W	5, 10	.1 to 5.6 kΩ	25 - 350	±400 (R<20Ω), ±260 (R≥20Ω)	1.812 x .500	D
		RW31	14 W	"	.1 to 6.8 kΩ	"	"	1.562 x .594	"
		RW33	26 W	"	.1 to 18 kΩ	"	"	3.062 x .594	"
		RW35	55 W	"	.1 to 43 kΩ	"	"	4.062 x .906	"
		RW37	113 W	"	.1 to 91 kΩ	"	"	6.062 x 1.312	"
		RW38	159 W	"	.1 to .15 MΩ	"	"	8.062 x 1.312	"
		RW47	210 W	"	.1 to .18 MΩ	"	"	10.562 x 1.312	"
		RW56	14 W	"	.1 to 9.1 kΩ	"	"	2.094 x .563	B
102 (MIL-R-22684)	Film (Insulated)	RL42...TX	2 W/500 V	2, 5	10 to 1.5 MΩ	70 - 150	±200	.728 x .336	A
103 (MIL-R-18546)	Wirewound (Power Type, Chassis Mounted)	RE77	75 W 2/	1	.05 to 29.4 kΩ	25 - 275	±30 (R≥2 K), ±50 (R<2 K)	3.594 x 1.781 x 2.843	E
		RE80	120 W 2/	1	.1 to 35.7 kΩ	25 - 275	±30 (R≥2 K), ±50 (R<2 K)	4.594 x 2.219 x 3.031	E
301 (MIL-R-39008)	Composition (Insulated), Established Reliability	RCR05	.125 W/150 V	5, 10	2.7 to 22 MΩ	70 - 130	±6.5 percent to ±25 percent at -55°C and ±5 percent to to ±15 percent at 105°C dependent on resistance resistance value	.160 x .066	A
		RCR07	.25 W/250 V	"	2.7 to 22 MΩ	"		.281 x .098	"
		RCR20	.5 W/350 V	"	1.0 to 22 MΩ	"		.416 x .161	"
		RCR32	1 W/500 V	"	1.0 to 22 MΩ	"		.593 x .240	"
		RCR42	2 W/500 V	"	10 to 22 MΩ	"		.728 x .336	"
302 (MIL-R-55182)	Film, Established Reliability	RNR50	.05 W/200 V .1 W/200 V 3/	.1, .5, 1 "	10 to .796 MΩ	125 - 175	±25, ±50, ±100	.170 x .080	A
		RNR55	.1 W/200 V .125/200 V 3/	" "	10 to 2.0 MΩ	"	"	.281 x .140	"
		RNR60	.125 W/250 V .25 W/300 V3/	" "	1.0 to 4.02 MΩ	"	"	.437 x 165	"
		RNR65	.25 W/300 V .5 W/350 V 3/	" "	1.0 to 8.06 MΩ	"	"	.656 x .250	"
		RNR70	.5 W/350 V .75 W/500 V3/	" "	1.0 to 15 MΩ	"	"	.875 x .328	"
		RNR75	1 W/750 V 2 W/750 V	" "	24.9 to 2 MΩ	"	±25	1.124 x .437	"
		RNC90	.3 W/300 V 3/ .6 W/300 V	1, .5, .1, .05, .01, .005	4.99 to 100 kΩ	"	±5 -65 ≤T≤125, ±10 125 ≤T≤175	.320 x .345 x .120	N
303 (MIL-R-39005)	Wirewound (Accurate), Established Reliability	RBR52	.5 W/600 V	.01, .05, .1, 1	.1 to .806 MΩ	125 - 145	±90 (R <1Ω), ±30 (1Ω ≤R<10Ω), ±15 (10Ω ≤R<100Ω), ±10(R≥100Ω)	1.020 x .390	A
		RBR53	.33 W/300 V	"	.1 to .499 MΩ	"		.770 x .390	"
		RBR54	.25 W/300 V	"	.1 to .255 MΩ	"	"	.770 x .265	"
		RBR55	.15 W/200 V	"	.1 to .150 MΩ	"	"	.520 x .265	"
		RBR56	.125 W/150 V	"	.1 to .1 MΩ	"	"	.364 x .265	"
		RBR57	.75 W/600 V	"	.1 to 1.37 MΩ	"	"	1.020 x .515	"
		RBR71	.125 W/150 V	"	.1 to .1 MΩ	"	"	.343 x .281	C
		RBR75	.125 W/150 V	"	.1 to 71.5 kΩ	"	"	.315 x .265	A
304 (MIL-R-39007)	Wirewound (Power Type), Established Reliability	RWR78	10 W	.1, .5, 1	.1 to 39.2 kΩ	25 - 275	±20 (R≥10Ω)	1.842 x .406	A
		RWR80	2 W	"	.1 to 1.21 kΩ	"	"	.437 x .125	"
		RWR81	1 W	"	.1 to .464 kΩ	"	"	.281 x .105	"
		RWR82	1.5 W	"	.1 to .931 kΩ	"	"	.328 x .094	"
		RWR84	7 W	"	.1 to 12.4 kΩ	"	"	.937 x .343	"
		RWR89	3 W	"	.1 to 3.57 kΩ	"	"	.622 x .218	"

See footnotes at end of table.

TABLE I. Fixed resistor selection guidance table - Continued.

Section	Type	Styles available in standard	Power and max voltage ratings	Resistance tolerance (± percent)	Ohmic range	Temperature range (°C) 1/	Resistance temperature coefficient (ppm/°C)	Max body size (inches)	Configuration (see fig. 4)
305 (MIL-R-39017)	Film (Insulated), Established Reliability	RLR05	.125 W/200 V	1, 2	4.7 to .3 MΩ	70 - 150	±100	.170 x .074	A
		RLR07	.25 W/250 V	"	10 to 10 MΩ	"	"	.281 x .098	"
		RLR20	.5 W/350 V	"	4.3 to 3.01 MΩ	"	"	.416 x .151	"
		RLR32	1 W/500 V	"	10 to 1.0 MΩ	"	"	.593 x .205	"
306 (MIL-R-39009)	Wirewound (Power Type, Chassis Mounted), Established Reliability	RER40	5 W	1	1 to 1.65 kΩ	25 - 275	±100 (R<1Ω), ±50 (1Ω ≤R<19.6Ω),	.662 x .677 x .351	F
		RER45	10 W 2/	"	1 to 2.80 kΩ	"	±30 (R≥20Ω)	.812 x .843 x .437	"
		RER50	20 W	"	1 to 6.04 kΩ	"	"	1.124 x 1.125 x .593	"
		RER55	30 W	"	1 to 19.6 kΩ	"	"	2.000 x 1.187 x .556	"
		RER60	5 W	"	.1 to 3.32 kΩ	"	"	.662 x .677 x .351	"
		RER65	10 W	"	.1 to 5.62 kΩ	"	"	.812 x .843 x .437	"
		RER70	20 W	"	.1 to 12.1 kΩ	"	"	1.124 x 1.125 x .593	"
		RER75	30 W	"	.1 to 39.2 kΩ	"	"	2.000 x 1.187 x .556	"
307 (MIL-R-55342)	Film, Chip, Established Reliability	RM0502	.02 W/40 V	1, 5, 10	5.6 to .1 MΩ	70 - 125	±100, ±300	.055 x .035 x .010/.040	T
		RM0505	.15 W/40 V	"	5.6 to .47 MΩ	"	"	.05 x .05 x .04	"
		RM0705	.10 W/40 V	"	5.6 to .1 MΩ	"	"	.10 x .05 x .04	"
		RM1005	.15 W/40 V	"	5.6 to .47 MΩ	"	"	.15 x .05 x .04	"
		RM1505	.10 W/50 V	"	5.6 to .1 MΩ	"	"	.075 x .05 x .04	"
		RM2208	.225 W/50 V	"	5.6 to 15 MΩ	"	"	.230 x .085 x .010/.040	"
308 (MIL-R-122)	Resistor, Fixed Precision	M122*01	.3 W/300 V	.005, .01, .05	10 to .1 MΩ	-55° to +175°C	Resistance value — ppm/°C	.302 x .325 x .105/1.375	U
		M122*03	.3 W/300 V	1, 5, 1.0	10 to .2 MΩ	-55° to 150°C	5 to greater, less than 10 — ±5	.302 x .325 x .105/1.375	U
		M122*06	.10 W/200 V	"	10 to .5 MΩ	-55° to +125°C	1 or greater, less than 5 — ±10	1.5 x .250 x 1.5 x 1.02	V
		M122*10	.15 W/200 V	"	10 to .4 MΩ	-55° to +150°C	less than 1 — ±50	.302 x .325 x 1.375 x .105	U

1/ Full load ambient operating temperature and zero load temperature, respectively.
2/ Mounted on a metal chassis.
3/ Power rating at 70°C (full load ambient operating temperature).

TABLE II. Special fixed resistor selection guidance table.

Section	Type	Styles available in standard	Schematics available in standard	Power ratings 1/ H	Power ratings 1/ K and M	Power ratings 1/ C and V	Resistance tolerance (± percent)	Ohmic range	Temperature range (°C) 2/	Resistance temperature coefficient (ppm/°C)	Max body size (inches)	Configuration (see fig. 4)
501 (MIL-R-83401)	Film (network)	RZ010	A B J	.2/1.4 .1/1.3	.2/1.4 .1/1.3 .05/1.2	.1/.7	.1,.5,1,2,5	10 to 1 MΩ	70 - 125	±50, ±100, ±300	.785 x .305 x .200	P
		RZ020	A B J	.2/1.6 .1/1.5	.2/1.6 .1/1.5 .05/1.4	.1/.8	.1,.5,1,2,5	10 to 1 MΩ	70 - 125	±50, ±100, ±300	.876 x .305 x .200	R
		RZ030	A B J	.05/.35 .025/.325 .015/.35	.05/.35 .025/.325 .015/.35		.5, 1, 2, 5	10 to 1 MΩ	70 - 125	±50, ±100, ±300	.385 x .305 x .075	Q
		RZ040	C H G		.2/1.8 .11/1.8 .2/1.0		1, 2, 5	10 to 1 MΩ	70 - 125	±100, ±300	.598 x .103 x .350	S
		RZ050	C H G		.2/1.8 .11/1.8 .2/1.0		1, 2, 5	10 to 1 MΩ	70 - 125	±100, ±300	.798 x .103 x .350	S
		RZ060	C H G		.2/1.8 .2/1.0		1, 2, 5	10 to 1 MΩ	70 - 125	±100, ±300	.998 x .352 x .103	S
		RZ070	C H G	.12/.60 .12/.36	.12/.60 .07/.60 .12/.36		.1,.5,1,2,5	27 to 1 MΩ	70 - 125	±50, ±100, ±300	.598 x .103 x .195	S
		RZ080	C H G	.12/.84 .12/.48	.12/.84 .07/.84 .12/.48		.1,.5,1,2,5	27 to 1 MΩ	70 - 125	±50, ±100, ±300	.798 x .103 x .197	S
		RZ090	C H G	.12/1.08 .12/.60	.12/1.08 .12/.60 .07/1.08		.1,.5,1,2,5	27 to 1 MΩ	70 - 125	±50, ±100, ±300	.998 x .103 x .197	S

Section	Type	Styles available in standard	Power rating	Thermal time constant	Dissipation constant	Resistive tolerance	Resistance ratio	Temperature range (°C)	Max body size (inches)	Configuration
502 (MIL-T-23648)	Thermistor	RTH06	.05 W	80 s	5 mW/°C	5 percent	680Ω min 4700Ω max	-55 to 125	.30 x .150 x .126	W
		RTH08	1.0 W	250 s	10 mW/°C	5 percent	180Ω min 1800Ω max	"	.028 x .50 x .36 x 1.50	W
		RTH10	1.5 W	450 s	15 mW/°C	5 percent	68Ω min 330Ω max	"	.92 x .113 x 1.50 x .45	W
		RTH22	0.5 W	60 s	15 mW/°C	5 percent	10 Ω min 39 kΩ max	"	.16 x .43 x 1.25 x .028	X
		RTH42	0.25 W	60 s	2.5 mW/°C	5 percent	10Ω min 10 kΩ max	"	.110 x 1.20 x .330 x .023	X

1/ Power rating at 70°C (full load ambient operating temperature).
2/ Full load ambient operating temperature and zero load temperature, respectively.

TABLE III. Variable resistor selection guidance table.

Section	Type	Styles available in standard	Power rating (watts)	Taper data	Nominal total resistance	Temperature range (°C) 1/	Resistance temperature coefficient (ppm/°C)	Max body size (inches)	Configuration (see fig. 4)
201 (MIL-R-94)	Composition (Insulated)	RV4	2, 1	A, C	50 to 5 MΩ	70 - 120		1.156 x .750	G
		RV6	.5, .25	A, C	100 to 5 MΩ	70 - 120		.516 x .593	G
202 (MIL-R-19)	Wirewound (Low Operating Temperature)	RA20	2, 1.1	A (lin),	3 to 15 kΩ	40 - 105		1.310 x .700	G
		RA30	4, 2.2	C (10% CW)	3 to 25 kΩ	40 - 105		1.710 x .810	G
203 (MIL-R-22)	Wirewound (Power Type)	RP05	5	Linear	10 to 5 kΩ	25 - 340		.525 x .687	G
		RP06	12.5	"	1 to 3.5 kΩ	"		.906 x .751	"
		RP10	25	"	2 to 5 kΩ	"		1.680 x 1.410	"
		RP15	50	"	1 to 10 kΩ	"		2.410 x 1.440	"
		RP20	75	"	2 to 10 kΩ	"		2.810 x 1.780	"
		RP25	100	"	2 to 10 kΩ	"		3.190 x 1.780	"
		RP30	150	"	2 to 10 kΩ	"		4.060 x 2.030	"
204 (MIL-R-12934)	Wirewound, Precision	RR0900	1.25	Linear	100 to 10 kΩ	85 - 150	±30, ±100	.880 x .812	H
		RR1000	2.0	"	100 to 50 kΩ	"	"	.880 x 1.625	"
		RR1100	1.5	"	100 to 20 kΩ	"	"	1.067 x .812	"
		RR1300	2.0	"	100 to 40 kΩ	"	"	1.442 x 1.062	"
		RR1400	3.0	"	200 to .2 MΩ	"	"	1.442 x 2.250	"
		RR2000	4.0	"	100 to 60 kΩ	"	"	2.005 x 1.312	"
		RR2100	5.0	"	200 to .25 MΩ	"	"	2.005 x 2.250	"
		RR3000	6.0	"	200 to .1 MΩ	"	"	3.005 x 1.312	"
		RR3100	1.25	"	100 to 10 kΩ	"	"	.906 x .750	"
		RR3200	1.50	"	100 to 20 kΩ	"	"	1.093 x .750	"
		RR3300	2.0	"	100 to 40 kΩ	"	"	1.468 x 1.062	"
		RR3400	4.0	"	100 to 60 kΩ	"	"	2.031 x 1.156	"
		RR3500	6.0	"	200 to 100 kΩ	"	"	3.031 x 1.156	"
		RR3700	1.5	"	100 to 50 kΩ	"	"	.906 x 1.076	"
		RR3900	1.5	"	100 to 100 kΩ	"	"	.906 x 1.219	"
		RR4000	2.0	"	100 to 50 kΩ	"	"	.890 x 1.500	"
		RR4100	5.0	"	200 to 250 kΩ	"	"	1.844 x 2.094	"
205 (MIL-R-39002)	Wirewound, Semi-Precision	RK09	1.5	Linear	10 to 50 kΩ	85 - 135	±70 (R≥50Ω), ±200 (R<50Ω)	.515 x .650	J
206 (MIL-R-27208)	Wirewound, (Adjustment Type)	RT26	.25		10 to 2 kΩ	85 - 150	±50	.185 x .270 x .270	K
207 (MIL-R-22097)	Non-Wirewound (Adjustment Type)	RJ24	.5		10 to 1 MΩ	85 - 150	±100, ±250	.375 x .375 x .150	K
208 (MIL-R-23285)	Non-Wirewound	RVC6	.5	A, C	100 to 2.5 MΩ	125 - 175	±250	.516 x .469	J
209 (MIL-R-39023)	Non-Wirewound, Precision	RQ090	1.0	Linear	100 to 1 MΩ	70 - 125		.880 x .810	H
		RQ100	2.5	"	1000 to 1 MΩ	"		.880 x 1.88	"
		RQ110	1.25	"	100 to 1 MΩ	"		1.067 x .810	"
		RQ150	1.50	"	100 to 1 MΩ	"		1.442 x 1.06	"
		RQ160	3.5	"	1000 to 3 MΩ	"		1.442 x 2.50	"
		RQ200	2.00	"	100 to 1 MΩ	"		2.005 x 1.31	"
		RQ210	4.5	"	1000 to 3 MΩ	"		2.005 x 2.90	"
		RQ300	3.00	"	100 to 1 MΩ	"		3.005 x 1.31	"

See footnotes at end of table.

TABLE III. Variable resistor selection guidance table - Continued.

Section	Type	Styles available in standard	Power rating (watts)	Taper data	Nominal total resistance	Temperature range (°C) 1/	Resistance temperature coefficient (ppm/°C)	Max body size (inches)	Configuration (see fig. 4)
401 (MIL-R-39015)	Wirewound (Lead-Screw Actuated), Established Reliability	RTR12	.75		10 to 10 kΩ	85 - 150	±50	1.260 x .200 x .330	L
		RTR22	.75		10 to 10 kΩ	"	"	.510 x .197 x .510	K
		RTR24	.75		10 to 5 kΩ	"	"	.390 x .245 x .390	K
402 (MIL-R-39035)	Non-Wirewound (Adjustment Type), Established Reliability	RJR12	.75		10 to 1 MΩ	85 - 150	±50, ±100, ±250	1.260 x .330 x .200	L
		RJR24	.5		10 to 1 MΩ	"	"	.390 x .195 x .420	K
		RJR26	.25		50 to 1 MΩ	"	"	.270 x .195 x .270	K
		RJR28	.3		100 to 2 MΩ	"	"	.510 x .110 x .180	L
		RJR50	.25		10 to 1 MΩ	"	"	.270 x .270 x .250	M

1/ Full load ambient operating temperature and zero load temperature, respectively.

TABLE IV. Military specification to NATO style cross reference.

Military specification	Military type	Equivalent NATO style	NEPR no.	Military specification	Military type	Equivalent NATO style	NEPR no.
FIXED RESISTORS							
MIL-R-26 (See section 101)	RW29	NRW01	5	MIL-R-55182 (See section 302 - Continued)	RNR65H	NRN02	6
	RW31	NRW02	"		RNR65J	NRN34	"
	RW33	NRW03	"		RNR65K	NRN54	"
	RW35	NRW04	"		RNR70E	NRN45	"
	RW37	NRW05	"		RNR70H	NRN03	"
	RW38	NRW06	"		RNR70J	NRN35	"
	RW47	NRW07	"		RNR70K	NRN55	"
	RW56	NRW09	"				
MIL-R-39008 (See section 301)	RCR05	NRC06	2	MIL-R-39005 (See section 303)	RBR52	NRB10	8
	RCR07	NRC02	"		RBR53	NRB09	"
	RCR20	NRC03	"		RBR54	NRB08	"
	RCR32	NRC04	"		RBR55	NRB07	"
	RCR42	NRC05	"		RBR56	NRB19	"
					RBR57	NRB18	"
					RBR71	NRB14	"
MIL-R-55182 (See section 302)	RNR50H	NRN22	6	MIL-R-39007 (See section 304)	RWR78	NRW53	72
	RNR50J	NRN31	"		RWR80	NRW54	"
	RNR50K	NRN51	"		RWR81	NRW55	"
	RNR55E	NRN42	"		RWR84	NRW56	"
	RNR55H	NRN21	"		RWR89	NRW57	"
	RNR55J	NRN32	"				
	RNR55K	NRN52	"	MIL-R-39017 (See section 305)	RLR05C	NRC16	4
	RNR60E	NRN43	"		RLR07C	NRC11	"
	RNR60H	NRN01	"		RLR20C	NRC12	"
	RNR60J	NRN33	"		RLR32C	NRC13	"
	RNR60K	NRN53	"		RLR42C	NRC15	"
	RNR65E	NRN44	"				
VARIABLE RESISTORS							
MIL-R-94 (See section 201)	RV4S	NRV06	10	MIL-R-22 (See section 203)	RP05	NRP08	11
	RV4T	NRV20	"		RP06	NRP07	"
	RV6S	NRV10	"		RP10	NRP02	"
	RV6T	NRV21	"		RP15	NRP03	"
MIL-R-19 (See section 202)	RA20	NRA08	9		RP20	NRP04	"
	RA30	NRA10	"		RP25	NRP05	"
					RP30	NRP06	"

TABLE V. Detail specification number by style number.

Style	Detail specification	Military specification	Section	Style	Detail specification	Military specification	Section
RA10	1	MIL-R-19	202	RJR28	5	MIL-R-39035	402
RA20	2	"	"	RJR50	4	"	"
RA30	3	"	"	RK09	1	MIL-R-39002	205
RBR52	1	MIL-R-39005	303	RK11	3	"	"
RBR53	2	"	"	RLR05	5	MIL-R-39017	305
RBR54	3	"	"	RLR07	1	"	"
RBR55	4	"	"	RLR20	2	"	"
RBR56	5	"	"	RLR32	3	"	"
RBR57	7	"	"	RL42...TX	8	MIL-R-22684	102
RBR71	6	"	"	RM0502	1	MIL-R-55342	307
RBR74	8	"	"	RM0505	2	"	"
RBR75	9	"	"	RM1005	3	"	"
RBR76	10	"	"	RM1505	4	"	"
RBR80	11	"	"	RM2208	5	"	"
RBR81	11	"	"	RM0705	6	"	"
RCR05	4	MIL-R-39008	301	RNC50	7	MIL-R-55182	302
RCR07	1	"	"	RNC55	1	"	"
RCR20	2	"	"	RNC60	3	"	"
RCR32	3	"	"	RNC65	5	"	"
RCR42	5	"	"	RNC70	6	"	"
RER40	2	MIL-R-39009	306	RNC75	10	"	"
RER45	2	"	"	RNC90	9	"	"
RER50	2	"	"	RNR50	7	"	"
RER55	2	"	"	RNR55	1	"	"
RER60	1	"	"	RNR60	3	"	"
RER65	1	"	"	RNR65	5	"	"
RER70	1	"	"	RNR70	6	"	"
RER75	1	"	"	RNR75	10	"	"
RE77	2	MIL-R-18546	103	RP05	15	MIL-R-22	203
RE80	2	"	"	RP06	1	"	"
RFP01	1	MIL-R-122	308	RP07	2	"	"
RFP03	3	"	"	RP10	3	"	"
RFP06	6	"	"	RP11	4	"	"
RFP10	10	"	"	RP15	5	"	"
RJR12	1	MIL-R-39035	402	RP16	6	"	"
RJR24	2	"	"	RP20	7	"	"
RJR26	3	"	"	RP25	8	"	"

TABLE V. Detail specification number by style number - Continued.

Style	Detail specification	Military specification	Section	Style	Detail specification	Military specification	Section
RP30	9	MIL-R-22	203	RR4000	31	MIL-R-12934	204
RP35	10	"	"	RR4100	32	"	"
RP40	11	"	"	RTH06	1	MIL-R-23648	502
RP45	12	"	"	RTH08	2	"	"
RP50	13	"	"	RTH10	3	"	"
RP55	14	"	"	RTH22	9	"	"
RQ051	10	MIL-R-39023	209	RTH42	19	"	"
RQ090	1	"	"	RTR12	1	MIL-R-39015	401
RQ091	9	"	"	RTR22	2	"	"
RQ100	6	"	"	RTR24	3	"	"
RQ110	2	"	"	RT10	2	MIL-R-27208	206
RQ150	3	"	"	RT26	10	"	"
RQ160	7	"	"	RT27	11	"	"
RQ200	4	"	"	RVC6	3	MIL-R23285	208
RQ210	8	"	"	RV2	4	MIL-R-94	201
RQ300	5	"	"	RV4	5	"	"
RR0900	1	MIL-R-12934	204	RV5	2	"	"
RR1000	6	"	"	RV6	3	"	"
RR1004	34	"	"	RWR78	7	MIL-R-39007	304
RR1100	2	"	"	RWR80	8	"	"
RR1300	19	"	"	RWR81	9	"	"
RR1400	20	"	"	RWR82	12	"	"
RR2000	4	"	"	RWR84	10	"	"
RR2002	33	"	"	RWR89	11	"	"
RR2100	9	"	"	RW29 to 39	3	MIL-R-26	101
RR2104	35	"	"	RW47	3	"	"
RR3000	5	"	"	RW56	4	"	"
RR3100	10	"	"	RZ010	1	MIL-R-83401	501
RR3200	15	"	"	RZ020	2	"	"
RR3300	16	"	"	RZ030	3	"	"
RR3400	17	"	"	RZ040	4	"	"
RR3500	18	"	"	RZ050	5	"	"
RR3600	27	"	"	RZ060	6	"	"
RR3601	36	"	"	RZ070	7	"	"
RR3700	28	"	"	RZ080	8	"	"
RR3800	29	"	"	RZ090	9	"	"
RR3900	30	"	"	2RV7	6	MIL-R-94	201

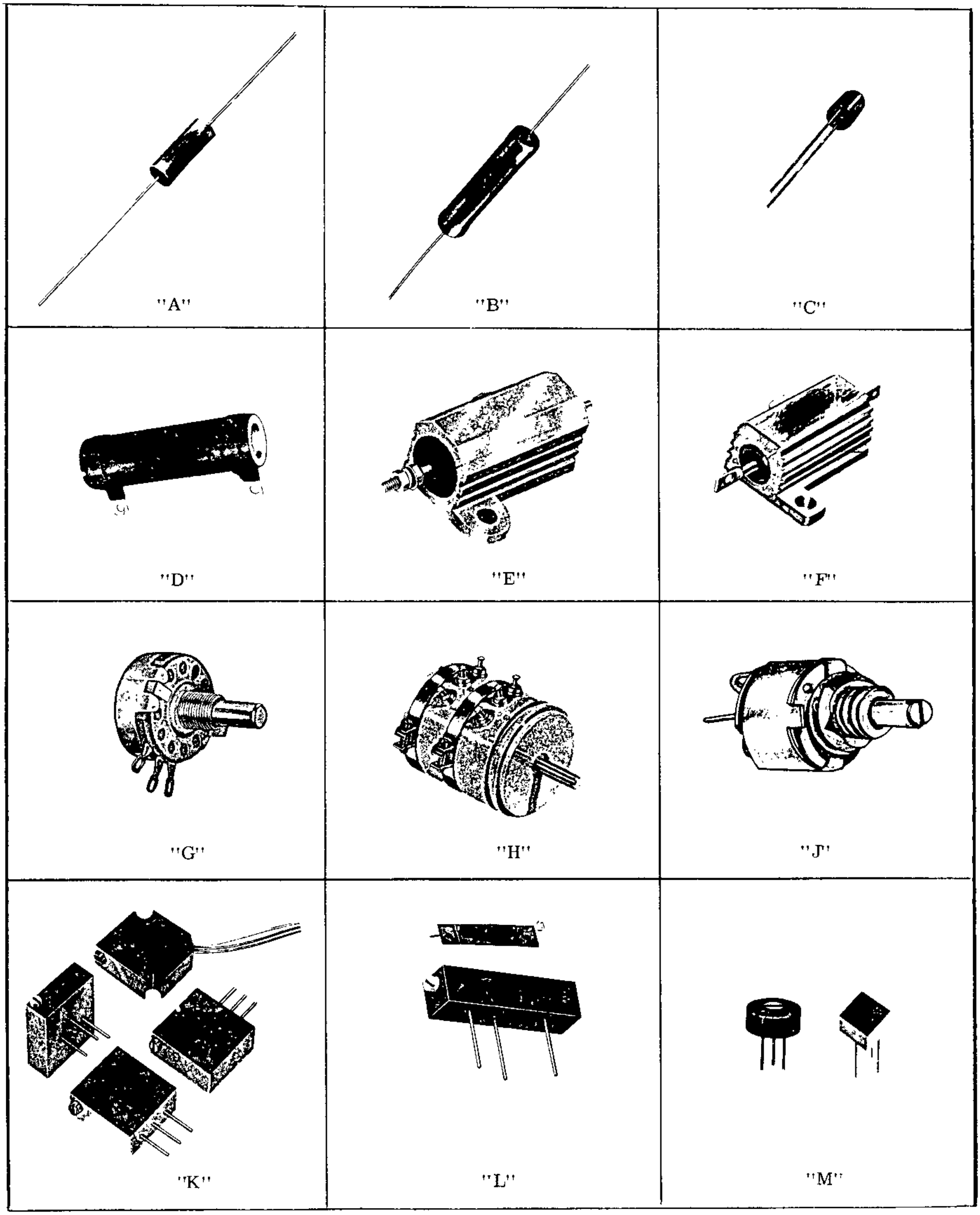


FIGURE 4. Configurations.

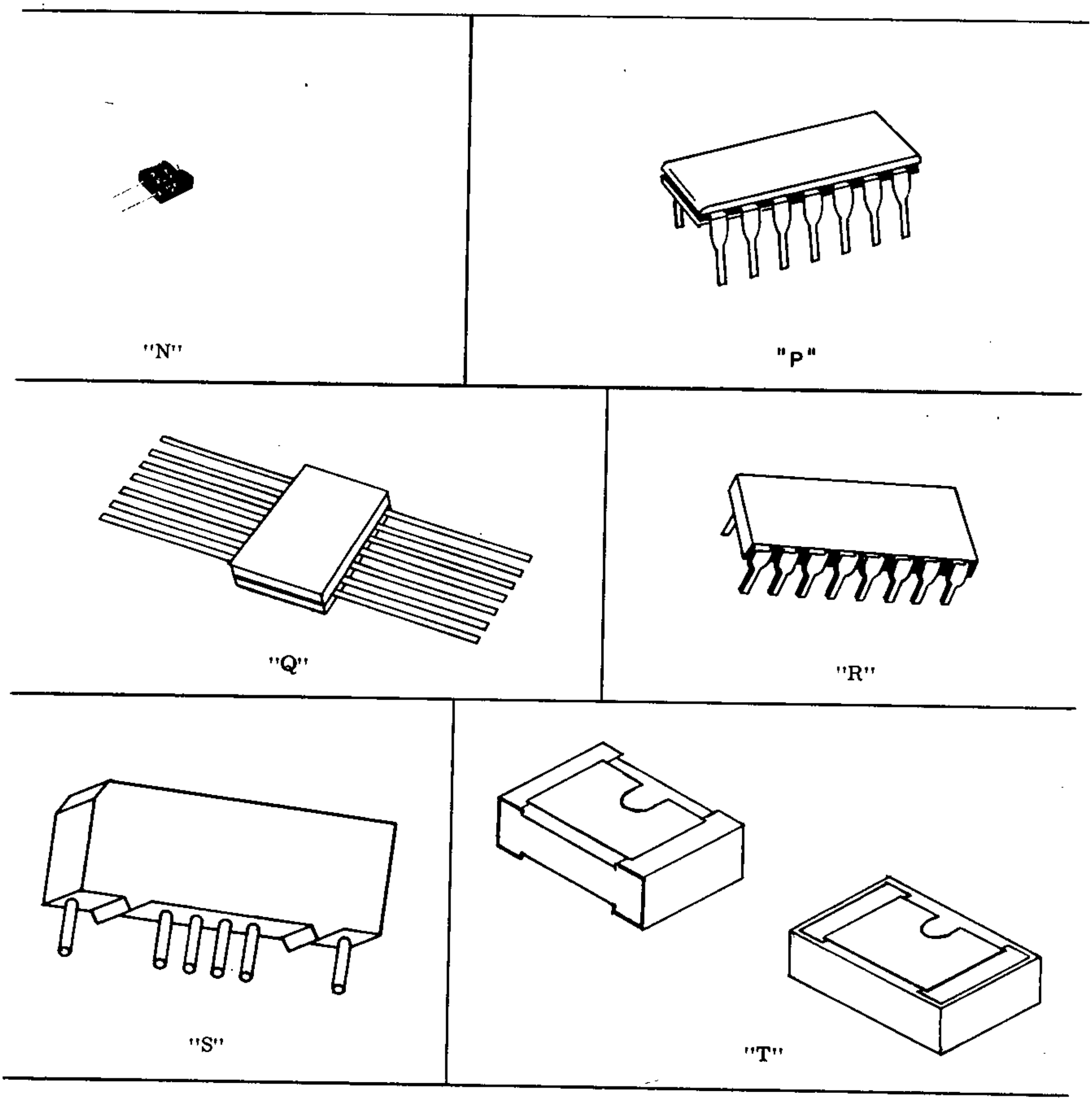


FIGURE 4. Configurations - Continued.

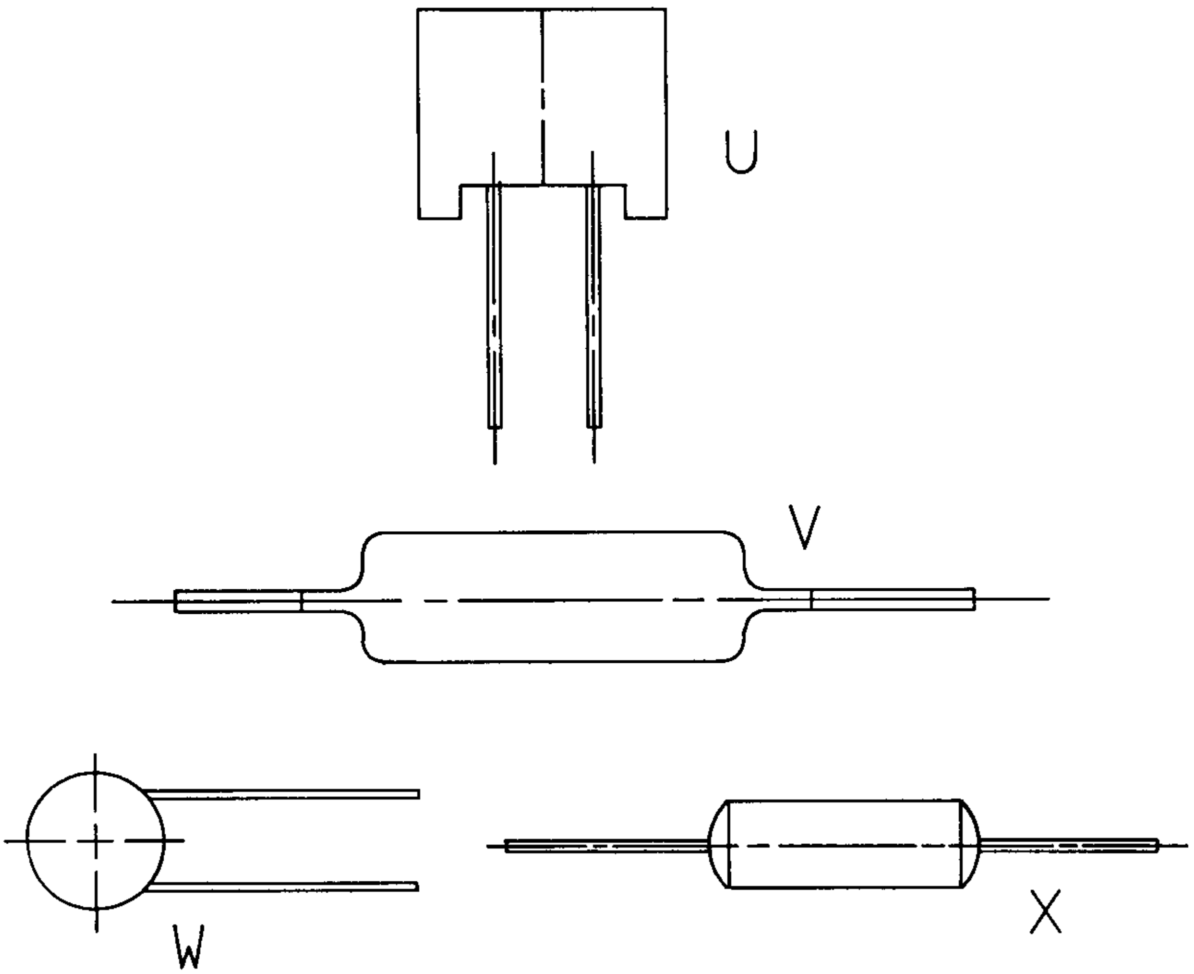


FIGURE 4. Configurations - Continued.

SECTION 100

RESISTORS, FIXED

SECTION 101

RESISTORS, FIXED, WIREWOUND (POWER TYPE)

STYLES RW29, RW31, RW33, RW35, RW37, RW38, RW47, AND RW56

(APPLICABLE SPECIFICATION: MIL-R-26)

1. SCOPE. This section covers power type, wirewound, fixed resistors. Included are general purpose radial tab styles of 5- and 10-percent initial resistance tolerances with power ratings ranging from 11 to 210 watts at 25°C, derated to 0 power at 350°C (characteristics V and N). These resistors are not designed for high frequency applications where the ac performance is of critical importance. They are especially suited for use in electrical, electronic, communication, and associated equipment.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. The construction of styles herein employs a measured length of resistance wire or ribbon of a known ohmic value wound in a precise manner where the pitch, effective wire coverage, and wire diameter are specification controlled. The continuous length of resistance wire (wire required to be free of joints, welds or bonds, and of uniform cross-section) is wound on a core or tube, usually of ceramic, and attached to end terminations (tabs or axial leads). The element assembly, including connections or terminations of the resistive element, are protected, insofar as necessary, by an enclosure or coating of insulating, moisture-resistant material (usually inorganic vitreous enamel or a silicone).

2.1.2 Power rating. These resistors have a power rating based on a continuous rated-wattage operation at an ambient temperature of 25°C, without exceeding a hot spot temperature of 350°C. If these resistors are to be operated at an ambient temperature greater than 25°C, the resistors should be derated in accordance with figure 101-1.

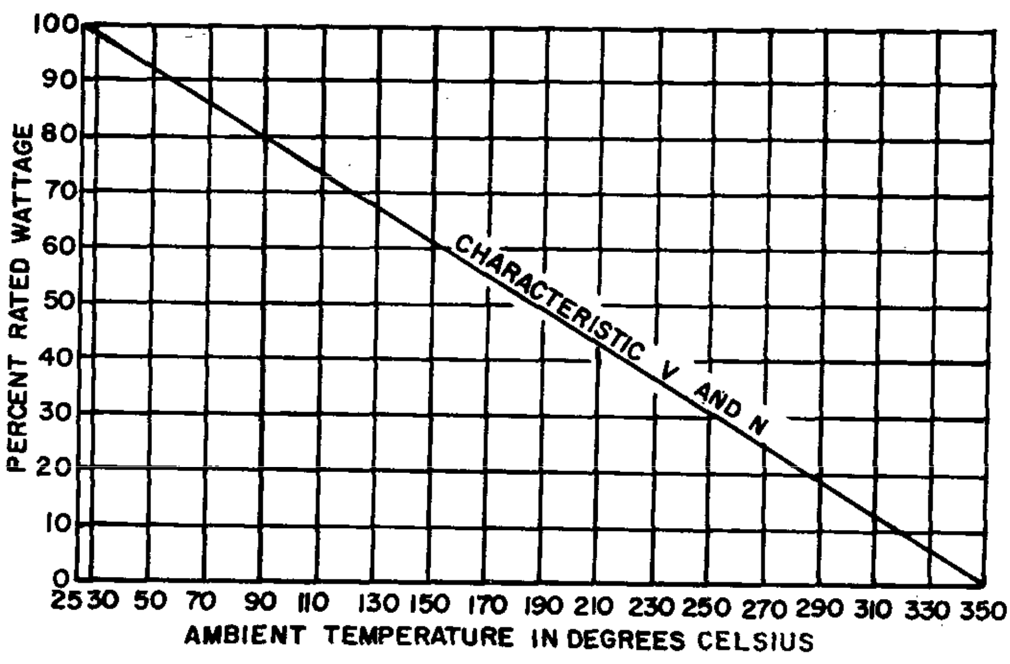


FIGURE 101-1. Derating curve for high ambient temperature.

2.1.3 Resistance wire. Wire size of less than .001 inch nominal diameter is not recommended for new design.

2.1.4 Derating for optimum performance. Because all of the electrical energy dissipated by a resistor is converted into heat energy, the temperature of the surrounding air becomes an influencing factor in the selection of a particular resistor for use in a specific application. The power rating for these resistors is based on operation at an ambient temperature of 25°C; however, in actual use, the resistors may not be operating at this temperature. After the desired resistance tolerance and the anticipated maximum ambient temperature have been determined, a safety factor of 2, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential, and one which will remain within specified tolerance limits.

2.1.5 Choice of style. Resistors to be used in equipment should be so chosen that, when mounted in the equipment, they will not operate at a temperature in excess of their rating. This should be applicable under the most severe conditions, as follows:

a. In the maximum specified ambient temperature.

b. Under conditions producing maximum temperature rise in each resistor.

c. For a sufficient length of time to produce maximum temperature rise, or for the maximum specified time.

d. With all enclosures in place.

e. With natural ventilation only. (This should permit the use of any special ventilating provisions included as a standard part of the equipment.)

f. At high altitude.

2.2 Spacing. When resistors are mounted in rows or banks, they should be so braced that, taking into consideration the restricted ventilation and heat dissipation by nearby resistors, no resistor in the rows or banks exceeds its maximum permissible hot-spot temperature. An appropriate combination of resistor spacing and resistor power rating must be chosen if this is to be insured.

2.3 Soldering. A solder with a minimum melting temperature of 350°C should be used for soldering. Care must be exercised in soldering low value and tighter tolerance resistors since high contact resistance may cause resistance changes exceeding the tolerance.

2.4 Mounting. Under conditions of severe shock or vibration, or a combination of both, resistors of all sizes described in this section should be mounted in such a fashion that the body of the resistor is restrained from movement with respect to the mounting base. It should be noted that if clamps are used, certain electrical characteristics of the resistor will be altered. The heat-dissipating qualities of the resistor will be enhanced or retarded depending on whether the clamping material is a good or poor heat conductor. Under less severe vibration conditions, axial lead styles may be supported by their leads only. The lead lengths should be kept as short as possible, 1/4 inch or less preferred, but not longer than 5/8 inch. The longer the lead, the more likely that a mechanical failure will occur. For mounting of tab-terminal resistors, use bracket assemblies specified on MS75009. Figure 101-2 provides an outline of these assemblies; see MS sheet for detailed information.

2.5 Secondary insulation. Where high voltages are present between resistor circuits and grounded surfaces on which resistors are mounted, secondary insulation capable of withstanding the voltage conditions should be provided between resistors and mountings or between mountings and ground.

2.6 Coating materials. Certain coating materials used in fabricating resistors furnished under MIL-R-26 may be subject to "outgassing" of volatile material when operated at surface temperatures over 200°C. This phenomena should be taken into consideration for equipment design.

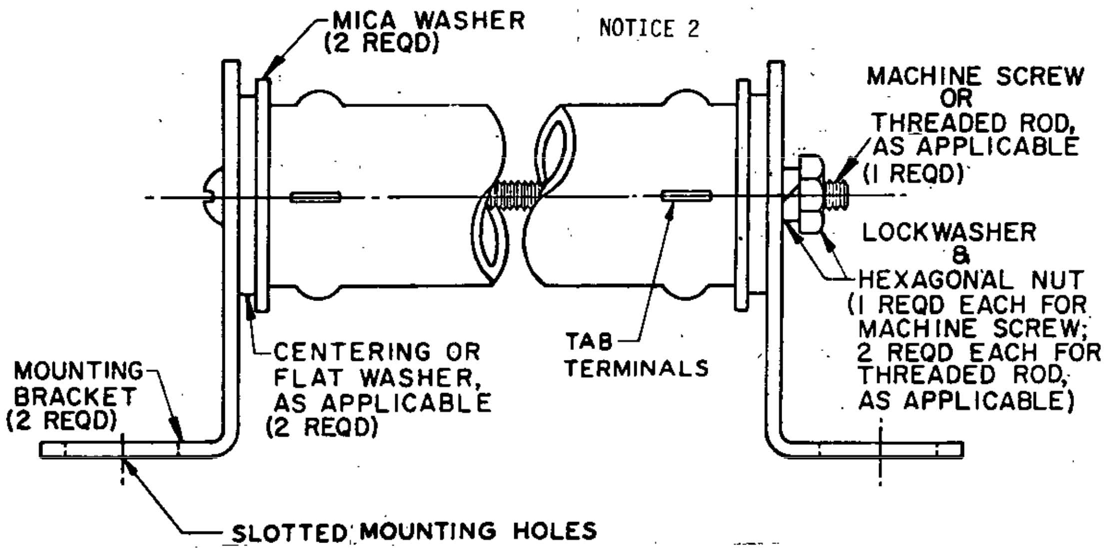


FIGURE 101-2. Bracket assembly.

3. ITEM IDENTIFICATION (see figures 101-3 and 101-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 101-3.

RW33 V 100 T

STYLE: The two-letter symbol "RW" identifies power-type, wirewound, fixed resistors; the two-digit number identifies the physical size and power rating.

CHARACTERISTIC: The single-letter symbol identifies the maximum operating temperature, the insulation resistance (IR) value, and resistance temperature characteristic as follows:

V 1/ – – – 350°C max oper temp; min IR of 100 MΩ;
N 1/ PPM/°C = $^{+650}_{-100}$ (R≥.1≤.449Ω), $^{+500}_{-100}$ (R≤.499 ≤1Ω), $^{+400}_{-200}$ (R≥1<10Ω), ±400 (R≥10<20Ω), ±260 (R ≥ 20Ω)

1/ V indicates inductively wound resistors; N indicates non-inductively wound resistors.

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 10 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

R10- - - - -	0.1 ohm
1R0- - - - -	1.0 ohm
101- - - - -	100 ohms
102- - - - -	1,000 ohms

CENTER TAP: The single-letter symbol "T" indicates that the resistor is center-tapped (style RW33, RW35, RW37, RW38, and RW47, if applicable).

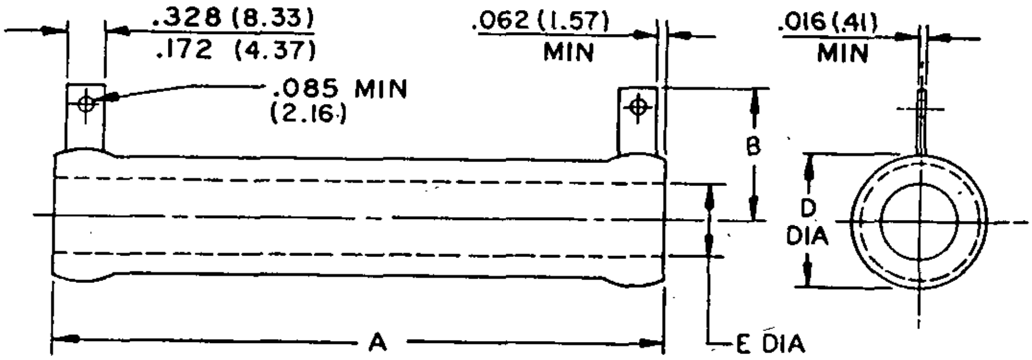
FIGURE 101-3. Type designation example.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 101-I.

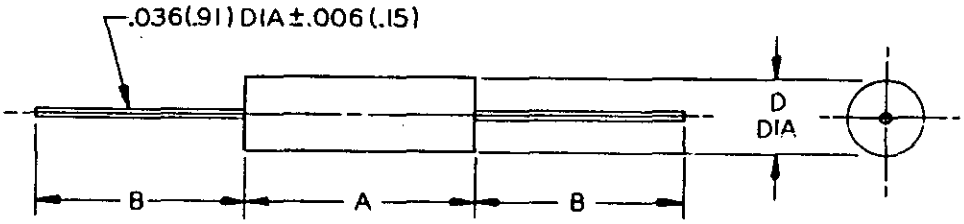
3.3 Decade values. The resistance values shall follow the standard decade of values as shown in the following:

Decade of values		
10	22	47
11	24	51
12	27	56
13	30	62
15	33	68
16	36	75
18	39	82
20	43	91

4. DELETED STYLES. Resistors, styles RW55, RW67, RW68, RW70, RW74, RW78, RW79, RW80, and RW81, formerly covered in this section, have been intentionally deleted and are no longer standard items for new design. For new design, use styles RWR74, RWR78, RWR80, RWR81, RWR84, and RWR89 of MIL-R-39007 (see section 304).



Styles RW29 to RW47 inclusive.



Style RW56.

INCHES	MM
.016	.41
.031	.79
.046	1.17
.062	1.57
.094	2.39
.125	3.18
.156	3.96
.172	4.37
.187	4.75
.312	7.92
.375	9.53
.469	11.91
.500	12.70
.594	15.09
.625	15.88
.703	17.86
.750	19.05
.812	20.62
.906	23.01
1.219	30.96
1.312	33.32
1.500	38.10
1.750	44.45
2.000	50.80
3.000	76.20
4.000	101.60
6.000	152.40
8.000	203.20
10.000	254.00

Style	Dimensions (inches)			
	A	B	D	E 1/
RW29	1.750 ±.062	.625 ±.125	.500 max	.172 min
RW31	1.500 ±.062	.625 ±.125	.594 max	.312 +.016 -.125
RW33	3.000 ±.062	.625 ±.125	.594 max	.187 min
RW35	4.000 ±.062	.812 ±.125	.906 max	.500 +.062 -.031
RW37	6.000 ±.062	1.219 ±.125	1.312 max	.703 min
RW38	8.000 ±.062	1.219 ±.125	1.312 max	.750 +.156 -.046
RW47	10.000 ±.062	1.219 ±.125	1.312 max	.703 min
RW56	2.000 ±.094	1.750 ±.375	.469 ±.094	---

1/ For styles RW35, RW37, RW38, and RW47, dimension "E" applies for at least 1/2 inch (12.70) from each end of the tube; the remainder of the core is not less than 1/4 inch (6.35) in diameter.

FIGURE 101-4. Fixed wirewound resistors (power type).

TABLE 101-I. Performance characteristics.

Features	RW29	RW31	RW33	RW35	RW37	RW38	RW47	RW56
Resistance tolerance (±percent)- - - - - - -	R<1Ω=10 R≥1Ω=5	See RW29	See RW29	See RW29	See RW29	See RW29	See RW29	See RW29
Min resistance (ohm)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Max resistance (kilohm)								
Characteristic V	5.6	6.8	18.0	43.0	91.0	150.0	180.0	9.1
Characteristic N	2.7	3.3	8.1	20.0	43.0	75.0	81.0	---
Resistance temperature characteristic (ppm/°C)	SEE FIGURE 101-3							
Power rating (watts) at 25°C	11	14	26	55	113	159	210	14
Max percent change in resistance (±) 1/								
Thermal shock	2	2	2	2	2	2	2	2
Short-time overload	2	2	2	2	2	2	2	2
Terminal strength	1	1	1	1	1	1	1	1
Dielectric withstanding voltage	.1	.1	.1	.1	.1	.1	.1	.1
High temperature exposure	2	2	2	2	2	2	2	2
Moisture resistance	2	2	2	2	2	2	2	2
Low temperature storage	2	2	2	2	2	2	2	2
Shock (specified pulse)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.2
Vibration, high frequency	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.2
Life (full load at 25°C) 2,000 hr	3	3	3	3	3	3	3	3
Insulation resistance (megohms)								
Dry (initial)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Wet (after moisture resistance)	100	100	100	100	100	100	100	100

1/ Total resistance change shall be considered as ± (_ percent +0.05 ohm).

SECTION 102

RESISTORS, FIXED, FILM, INSULATED

STYLE RL42 ..... TX

(APPLICABLE SPECIFICATION: MIL-R-22684)

1. SCOPE. This section covers insulated, film, fixed resistors having a film resistance element and axial leads. These resistors are capable of full-load operation at an ambient temperature of 70°C and have a resistance-temperature characteristic of ±200 parts per million per degree Celsius (ppm/°C).

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. In these resistors, the resistance element consists of a film-type resistance element which has been formed on a substrate by one of several processes depending upon the manufacturer. The element is spiraled to achieve ranges in resistance value and, after lead attachment, the element is coated to protect it from moisture or other detrimental environmental conditions.

2.1.2 Power rating. These resistors have a power rating based on continuous, full-load operation at an ambient temperature of 70°C. If the resistors are to be operated at temperatures exceeding 70°C, the resistors must be derated in accordance with figure 102-1.

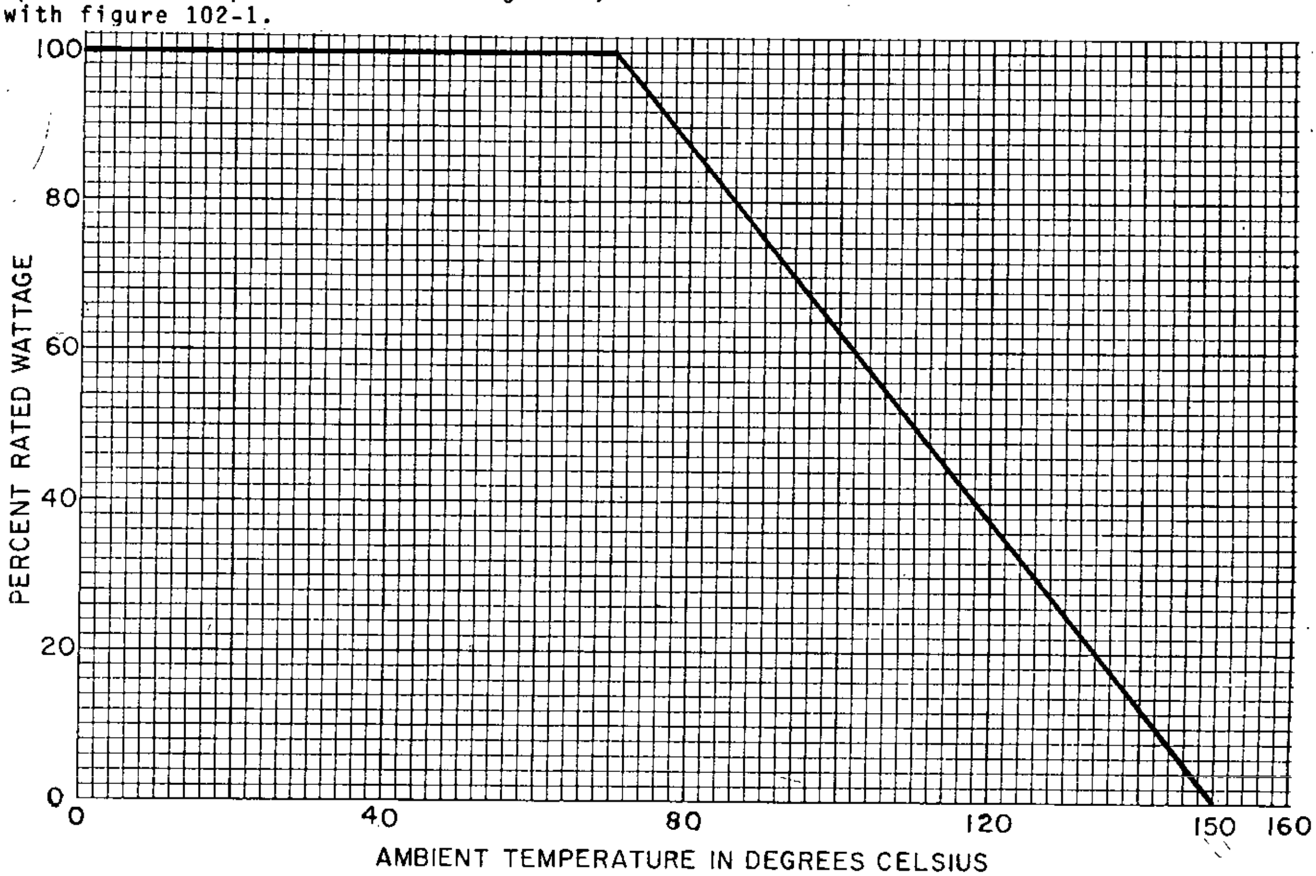


FIGURE 102-1. Derating curve for high ambient temperature.

2.1.3 Derating for optimum performance. After the maximum ambient temperature has been determined, a safety factor of two applied to the wattage is recommended in order to insure the selection of a resistor with an adequate wattage dissipation potential.

2.1.4 Resistance tolerance. Designers should bear in mind that operation of these resistors under the ambient conditions for which military equipment is designed may cause permanent or temporary changes in resistance sufficient to exceed their initial tolerance. In particular, operation at extreme temperatures may cause relatively large temporary changes in resistance.

2.2 Maximum voltage. The maximum continuous working voltage of 500 volts should in no case be exceeded, regardless of the theoretically calculated rated voltage.

2.3 Noise. Noise output is uncontrolled by the specification but is considered a negligible quantity.

2.4 Shelf life. MIL-R-22684 estimates a change of resistance of .2 percent (average) per year under normal storage conditions (25° ±10°C) with relative humidity not exceeding 90 percent).

3. ITEM IDENTIFICATION (see figures 102-2 through 102-4).

3.1 Part number. The part number is used for identifying the resistor as shown in figure 102-2.

M22684/08 - 1001

SPECIFICATION NUMBER: The number identifies the detail specification number (indicating MIL-R-22684/8).

DASH NUMBER: The applicable dash number is as indicated in table 102-I and corresponds to the type designation as per figure 102-3.

FIGURE 102-2. Part number example.

3.2 Type designation (for reference only). The type designation is used for describing the resistor as shown in figure 102-3.

RL42 S 100 G TX

STYLE: The two-letter symbol "RL" identifies insulated, film, fixed resistors; the two-digit number identifies the size and power rating.

TERMINAL: The single-letter symbol "S" identifies solderable terminals.

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See table 102-I and the following example.)

EXAMPLE:

100- - - - - 10 ohms
201- - - - - 200 ohms
155- - - - - 1,500,000 ohms

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

G - - - - - ±2 percent
J - - - - - ±5 percent

TX IDENTIFICATION: The symbol "TX" is a Government designation signifying additional quality assurance requirements.

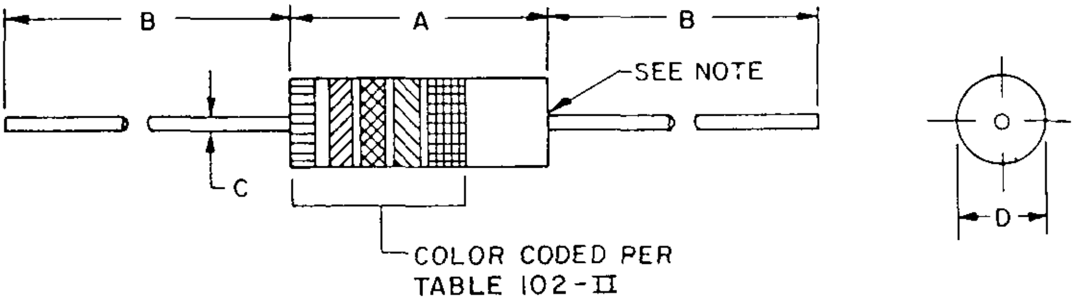
FIGURE 102-3. Type designation example.

TABLE 102-I. Part number designation.

Dash number Resistance tolerance G	J	Nominal total resistance Ohms	Type designation 1/	Dash number Resistance tolerance G	J	Nominal total resistance Ohms	Type designation 1/
1001	1002	10	RL42S100_TX	1127	1128	4,300	RL42S432_TX
1003	1004	11	RL42S110_TX	1129	1130	4,700	RL42S472_TX
1005	1006	12	RL42S120_TX	1131	1132	5,100	RL42S512_TX
1007	1008	13	RL42S130_TX	1133	1134	5,600	RL42S562_TX
1009	1010	15	RL42S150_TX	1135	1136	6,200	RL42S622_TX
1011	1012	16	RL42S160_TX	1137	1138	6,800	RL42S682_TX
1013	1014	18	RL42S180_TX	1139	1140	7,500	RL42S752_TX
1015	1016	20	RL42S200_TX	1141	1142	8,200	RL42S822_TX
1017	1018	22	RL42S220_TX	1143	1144	9,100	RL42S912_TX
1019	1020	24	RL42S240_TX	1145	1146	10,000	RL42S103_TX
1021	1022	27	RL42S270_TX	1147	1148	11,000	RL42S113_TX
1023	1024	30	RL42S300_TX	1149	1150	12,000	RL42S123_TX
1025	1026	33	RL42S330_TX	1151	1152	13,000	RL42S133_TX
1027	1028	36	RL42S360_TX	1153	1154	15,000	RL42S153_TX
1029	1030	39	RL42S390_TX	1155	1156	16,000	RL42S163_TX
1031	1032	43	RL42S430_TX	1157	1158	18,000	RL42S183_TX
1033	1034	47	RL42S470_TX	1159	1160	20,000	RL42S203_TX
1035	1036	51	RL42S510_TX	1161	1162	22,000	RL42S223_TX
1037	1038	56	RL42S560_TX	1163	1164	24,000	RL42S243_TX
1039	1040	62	RL42S620_TX	1165	1166	27,000	RL42S273_TX
1041	1042	68	RL42S680_TX	1167	1168	30,000	RL42S303_TX
1043	1044	75	RL42S750_TX	1169	1170	33,000	RL42S333_TX
1045	1046	82	RL42S820_TX	1171	1172	36,000	RL42S363_TX
1047	1048	91	RL42S910_TX	1173	1174	39,000	RL42S393_TX
1049	1050	100	RL42S101_TX	1175	1176	43,000	RL42S433_TX
1051	1052	110	RL42S111_TX	1177	1178	47,000	RL42S473_TX
1053	1054	120	RL42S121_TX	1179	1180	51,000	RL42S513_TX
1055	1056	130	RL42S131_TX	1181	1182	56,000	RL42S563_TX
1057	1058	150	RL42S151_TX	1183	1184	62,000	RL42S623_TX
1059	1060	160	RL42S161_TX	1185	1186	68,000	RL42S683_TX
1061	1062	180	RL42S181_TX	1187	1188	75,000	RL42S753_TX
1063	1064	200	RL42S201_TX	1189	1190	82,000	RL42S823_TX
1065	1066	220	RL42S221_TX	1191	1192	91,000	RL42S913_TX
1067	1068	240	RL42S241_TX			Megohm	
1069	1070	270	RL42S271_TX	1193	1194	0.10	RL42S104_TX
1071	1072	300	RL42S301_TX	1195	1196	0.11	RL42S114_TX
1073	1074	330	RL42S331_TX	1197	1198	0.12	RL42S124_TX
1075	1076	360	RL42S361_TX	1199	1200	0.13	RL42S134_TX
1077	1078	390	RL42S391_TX	1201	1202	0.15	RL42S154_TX
1079	1080	430	RL42S431_TX	1203	1204	0.16	RL42S164_TX
1081	1082	470	RL42S471_TX	1205	1206	0.18	RL42S184_TX
1083	1084	510	RL42S511_TX	1207	1208	0.20	RL42S204_TX
1085	1086	560	RL42S561_TX	1209	1210	0.22	RL42S224_TX
1087	1088	620	RL42S621_TX	1211	1212	0.24	RL42S244_TX
1089	1090	680	RL42S681_TX	1213	1214	0.27	RL42S274_TX
1091	1092	750	RL42S751_TX	1215	1216	0.30	RL42S304_TX
1093	1094	820	RL42S821_TX	1217	1218	0.33	RL42S334_TX
1095	1096	910	RL42S911_TX	1219	1220	0.36	RL42S364_TX
1097	1098	1,000	RL42S102_TX	1221	1222	0.39	RL42S394_TX
1099	1100	1,100	RL42S112_TX	1223	1224	0.43	RL42S434_TX
1101	1102	1,200	RL42S122_TX	1225	1226	0.47	RL42S474_TX
1103	1104	1,300	RL42S132_TX	1227	1228	0.51	RL42S514_TX
1105	1106	1,500	RL42S152_TX	1229	1230	0.56	RL42S564_TX
1107	1108	1,600	RL42S162_TX	1231	1232	0.62	RL42S624_TX
1109	1110	1,800	RL42S182_TX	1233	1234	0.68	RL42S684_TX
1111	1112	2,000	RL42S202_TX	1235	1236	0.75	RL42S754_TX
1113	1114	2,200	RL42S222_TX	1237	1238	0.82	RL42S824_TX
1115	1116	2,400	RL42S242_TX	1239	1240	0.91	RL42S914_TX
1117	1118	2,700	RL42S272_TX	1241	1242	1.0	RL42S105_TX
1119	1120	3,000	RL42S302_TX	1243	1244	1.1	RL42S115_TX
1121	1122	3,300	RL42S332_TX	1245	1246	1.2	RL42S125_TX
1123	1124	3,600	RL42S362_TX	1247	1248	1.3	RL42S135_TX
1125	1126	3,900	RL42S392_TX	1249	1250	1.5	RL42S155_TX

1/ Complete type designation includes the letter "G" or "J" for applicable resistance tolerance.

STYLE RL42 ..... TX



INCHES	MM
.043	1.09
.047	1.19
.300	7.62
.336	8.53
.648	16.46
.728	18.49
1.375	34.92
1.625	41.28

Style	Dimensions (inches)							
	A		B		C		D	
	Min	Max	Min	Max	Min	Max	Min	Max
RL42···TX	.648	.728	1.375	1.625	.043	.047	.300	.336

NOTE: The end of the body shall be that point at which the diameter equals the nearest drill size larger than 250 percent of the nominal lead diameter. The leads are solderable to within .125 inch (3.18 mm) of the resistor body.

FIGURE 102-4. Fixed film resistors (insulated).

TABLE 102-II. Color code for film-type resistors.

Band A 1/		Band B 2/		Band C 3/		Band D 4/		Band E 5/	
Color	First significant figure	Color	Second significant figure	Color	Multiplier	Color	Resistance tolerance (percent)	Color	Terminal
Black	0	Black	0	Black	1	Gold	±5	Green	Solderable
Brown	1	Brown	1	Brown	10	Red	±2		
Red	2	Red	2	Red	100				
Orange	3	Orange	3	Orange	1,000				
Yellow	4	Yellow	4	Yellow	10,000				
Green	5	Green	5	Green	100,000				
Blue	6	Blue	6	Blue	1,000,000				
Purple (Violet)	7	Purple (Violet)	7	Silver	0.01				
Gray	8	Gray	8	Gold	0.1				
White	9	White	9						

1/ The first significant figure of the resistance value.

2/ The second significant figure of the resistance value.

3/ The multiplier. (The multiplier is the factor by which the two significant figures are multiplied to yield the nominal resistance value.)

4/ The resistance tolerance.

5/ Indicates a solderable terminal and is the "TX" indicator band (This band is approximately 1-1/2 times the width of other bands.).

Example of color coding 5100 ohms ±5 percent, solderable leads:

Band A, green; Band B, Brown; Band C, red; Band D, gold; Band E, green.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 102-III.

TABLE 102-III. Performance characteristics.

Features	Specification number MIL-R-22684/8
Power rating (at 70°C) (watts) - - - - - - - - -	2
Min resistance (ohms) - - - - - - - - - - - - - -	10
Max resistance (megohms) - - - - - - - - - - - - -	1.5
Max continuous working voltage (volts) - - - -	500
Resistance temperature characteristic (ppm/°C)	±200
Max percent change in resistance 1/:	
Temperature cycling - - - - - - - - - - - - -	±1.0 percent
Low-temperature operation- - - - - - - - - - -	±0.5 percent
Short-time overload - - - - - - - - - - - - - -	±0.5 percent
Terminal strength- - - - - - - - - - - - - - -	±0.5 percent
Dielectric withstanding voltage- - - - - - - -	±0.5 percent
Resistance to soldering heat - - - - - - - - -	±0.5 percent
Moisture resistance - - - - - - - - - - - - - -	±1.5 percent
Life -	±2.0 percent
Shock, medium impact - - - - - - - - - - - - -	±0.5
Vibration, high frequency- - - - - - - - - - -	±0.5
Dielectric withstanding voltage (volts rms):	
Atmospheric - - - - - - - - - - - - - - - - - -	1,000
Barometric - - - - - - - - - - - - - - - - - - -	500
Insulation resistance (megohms):	
Dry -	1,000
Wet (after moisture resistance)- - - - - - - -	100

1/ Where total resistance change is 1 percent or less, it shall be considered as ± (percent + 0.05 ohm).

NOTE: All leads are solderable in accordance with method 208 of MIL-STD-202.

SECTION 103

RESISTORS, FIXED, WIREWOUND (POWER TYPE, CHASSIS MOUNTED)

STYLES RE77 AND RE80

(APPLICABLE SPECIFICATION: MIL-R-18546)

1. SCOPE. This section covers chassis-mounted, power-type, wirewound, fixed resistors having a wirewound resistance element and lug-type axial leads. These resistors are capable of full-load operation at an ambient temperature of 25°C when mounted on the specified chassis area. These resistors are suitable for use at high ambient temperatures where space limitations are important and the principle of heat dissipation through a metal mounting surface can be utilized. These resistors are not suitable for application where the ac characteristics are of critical importance; however, provisions have been made to minimize the inductance.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. In general, the element construction is similar to the processes and materials discussed in section 101; however, in this type of resistor, the finished resistor element and termination caps are sealed by a coating material. The coated element is then inserted in a finned aluminum alloy housing which completes the sealing of the element from detrimental environments, and provides a radiator and a heat sink for heat dissipation. These resistors must be wound either inductively or noninductively and the type of winding is identified by the type designation symbol.

2.1.2 Power rating. These resistors have a power rating based on continuous, full-load operation at an ambient temperature of 25°C and with a specified chassis area. If the resistors are to be operated at temperatures exceeding 25°C, the resistors must be derated in accordance with figure 103-1. (See 2.1.3 for chassis area derating.)

2.1.3 Chassis derating. These resistors, as noted in 2.1.2, are assigned power ratings when mounted on test chassis areas at 25°C. Figure 103-2 provides the chassis area derating curves for these resistors.

2.1.4 Derating for optimum performance. When the chassis area and the anticipated maximum ambient temperatures have been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential.

2.1.5 Choice of style. Resistors to be used in equipment should be so chosen that, when mounted in the equipment, they will not be required to operate at a temperature in excess of their rating. This should be applicable under the most severe conditions as follows:

a. In the maximum specified ambient temperature, limited chassis area.

b. Under conditions producing maximum temperature rise in each resistor.

c. For a sufficient length of time to produce maximum temperature rise, or for the maximum specified time.

d. With all enclosures in place.

e. With natural ventilation only. (This should permit the use of any special ventilating provisions included as a standard part of the equipment.)

f. At high altitude.

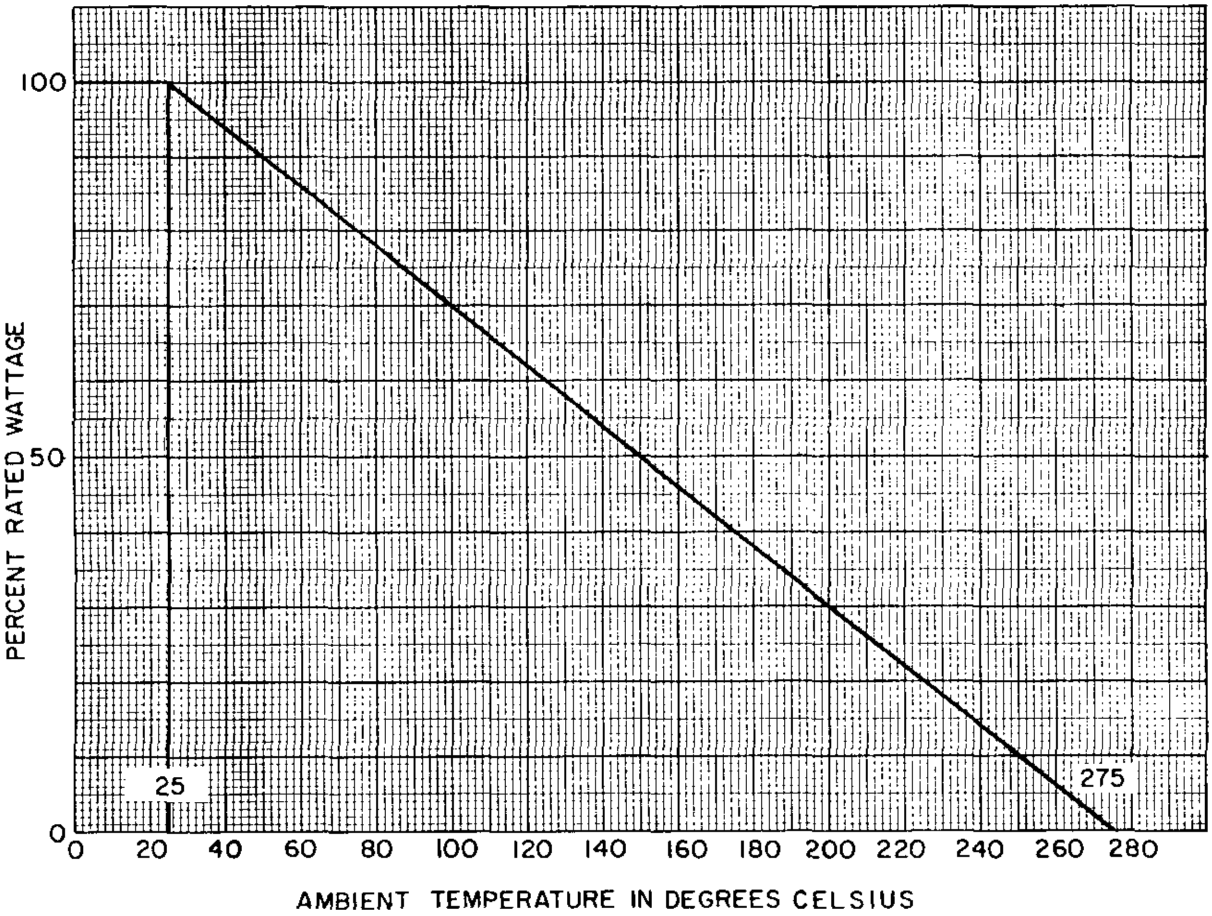


FIGURE 103-1. Derating curve for high ambient temperature.

2.2 Spacing. When resistors are mounted in rows or banks, they should be so spaced that, taking into consideration the restricted ventilation and heat dissipation by nearby resistors, none of the resistors in the row or bank exceeds its maximum permissible continuous operating temperature. An appropriate combination of resistor spacing and resistor power rating must be chosen if this is to be assured. In view of the chassis heat dissipation principle of these resistors, particular care must be exercised in order that the chassis temperature rise does not damage nearby components.

2.3 Soldering. A solder with a minimum melting temperature of 300°C should be used in soldering.

3. ITEM IDENTIFICATION (see figures 103-3 and 103-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 103-3.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 103-I.

3.3 Decade values. The resistance values shall follow the decade of values as shown in the following:

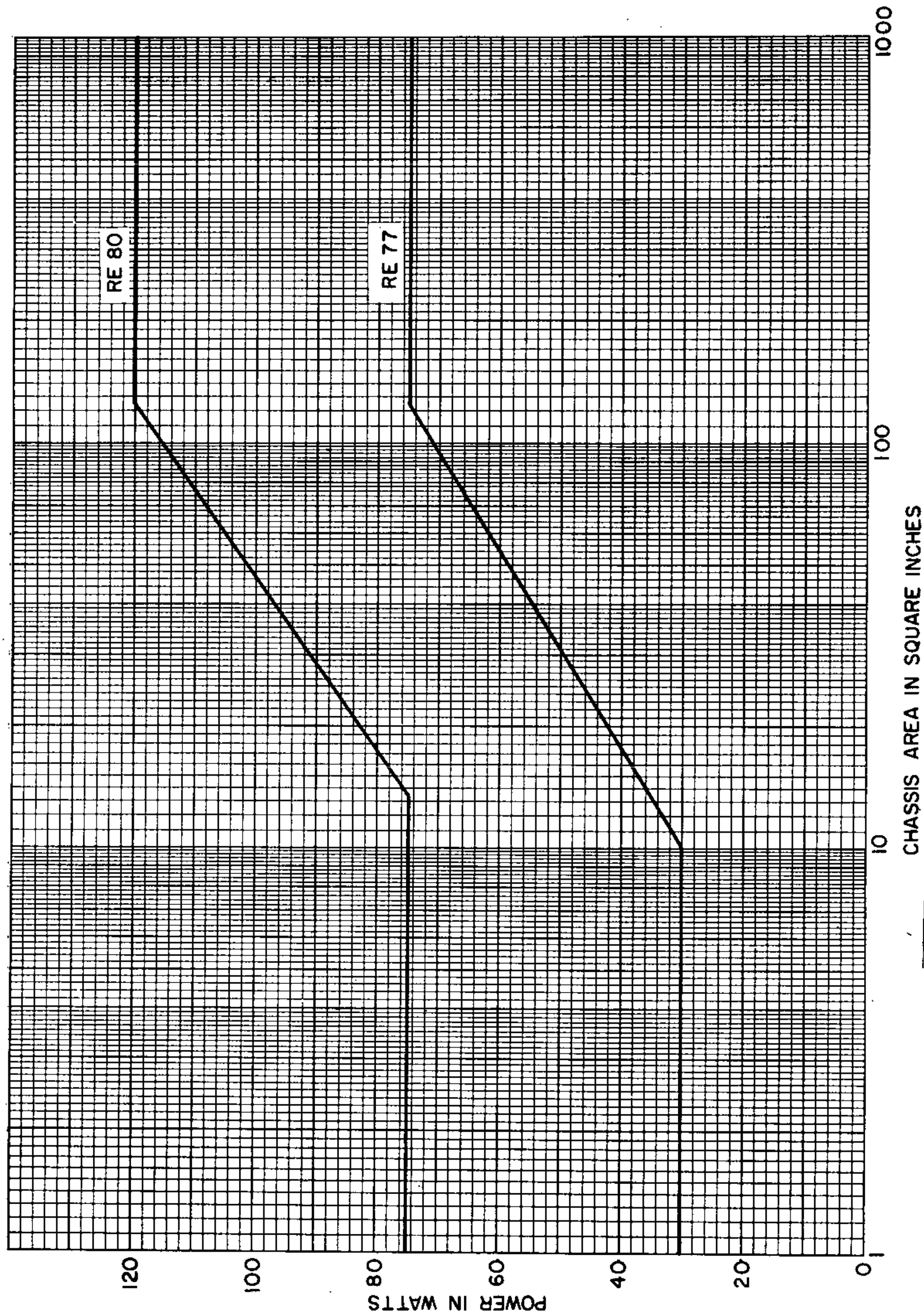


FIGURE 103-2. Chassis area derating curves.

Resistance values for the 10 to 100 decade					
10.00	15.40	22.60	-----	-----	-----
10.20	15.80	23.20	33.20	47.50	68.10
10.50	-----	23.70	34.00	48.70	69.80
10.70	16.20	-----	34.80	49.90	71.50
11.00	16.50	24.30	35.70	-----	73.20
11.30	16.90	24.90	-----	51.10	75.00
11.50	17.40	25.50	36.50	52.30	76.80
11.80	17.80	26.10	37.40	53.60	78.70
-----	-----	26.70	38.30	54.90	80.60
12.10	18.20	-----	-----	-----	-----
12.40	18.70	27.40	39.20	56.20	82.50
12.70	19.10	28.00	40.20	57.60	84.50
13.00	19.60	28.70	41.20	59.00	86.60
13.30	20.00	29.40	42.20	60.40	88.70
13.70	20.50	-----	-----	61.90	90.90
14.00	21.00	30.10	43.20	-----	-----
14.30	21.50	30.90	44.20	63.40	93.10
14.70	-----	31.60	45.30	64.90	95.30
15.00	22.10	32.40	46.40	66.50	97.60

4. DELETED STYLES. Resistors, styles RE60, RE65, RE70, and RE75, formerly covered in this section, have been intentionally deleted and are no longer standard items for new design. For new design, use styles RER40, RER45, RER50, RER55, RER60, RER65, RER70, and RER75 of MIL-R-39009 (see section 306).

RE77 G 1001

STYLE: The two-letter symbol "RE" identifies chassis-mounted, power type, wirewound fixed resistors; the two-digit number identifies physical size and power rating.

CHARACTERISTIC: The single-letter symbol identifies the maximum continuous operating temperature and type of winding as follows:

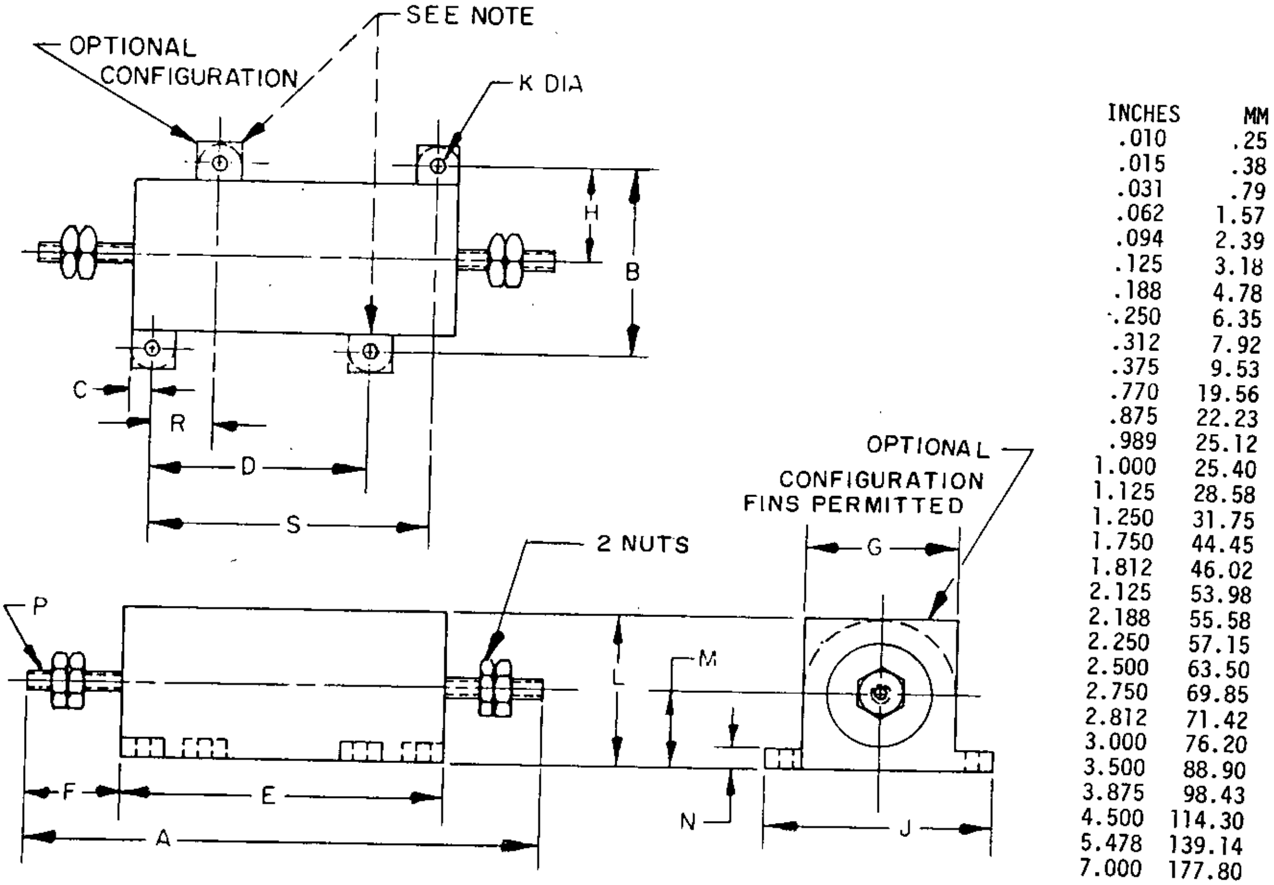
G (inductively wound)
N (noninductively wound) - - 275°C max cont oper temp

* RESISTANCE: The four-digit number identifies the nominal resistance value, expressed in ohms; the first three digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

R100- - - - - 0.10 ohm
1R00- - - - - 1.0 ohm
1001- - - - - 1,000 ohms
1002- - - - - 10,000 ohms

FIGURE 103-3. Type designation example.



Style	A	B	C ±.031	D	E ±.094	F	G ±.031	H ±.031
RE77	5.478 ±.094	2.250 ±.010	.375		3.500	.989 ±.031	1.812	1.125
RE80	7.000 ±.125	2.500 ±.015	.312	3.000 ±.010	4.500	1.250 ±.062	2.125	1.250

Style	J ±.031	K ±.010	L ±.031	M ±.062	N ±.031	P	R ±.010	S ±.010
RE77	2.812	.188	1.750	.770	.188	12-24 UNC-2A		2.750
RE80	3.000	.188	2.188	1.000	.250	1/4-20 UNC-2A	.875	3.875

NOTE: Mounting tabs apply to RE80 only.

FIGURE 103-4. Fixed wirewound resistors (power type, chassis mounted).

TABLE 103-I. Performance characteristics.

Features	Style RE77	Style RE80
Max resistance-temperature characteristic in parts per million ppm/°C (reference to 25°C) R > 2,000 ohms	30	30
R ≥ 2,000 ohms	50	50
Max ambient temperature at rated wattage	25°C	25°C
Max ambient at zero wattage derating	275°C	275°C
Min resistance (ohm)		
Characteristic G	0.0511	0.10
Characteristic N	1.0	1.0
Max resistance (ohms) 1/		
Characteristic G	29,400	35,700
Characteristic N	14,700	17,400
Power rating (chassis mounted) in watts	75	120
Power rating (free air) in watts	30	75
Max weight (grams)		
Characteristic G	400	800
Characteristic N	440	880
Max percent change in resistance (±) 2/		
Temperature	0.5	0.5
Dielectric withstanding voltage	0.2	0.2
Thermal shock	0.5	0.5
Momentary overload	0.5	0.5
Moisture resistance	1.0	1.0
Terminal strength	0.2	0.2
Shock (specified pulse)	0.2	0.2
Vibration, high frequency	0.2	0.2
Life	1.0	1.0
Resistance tolerance (± percent)	1.0	1.0
Insulation resistance (megohms) (minimum):		
Dry	10,000	10,000
Wet (after moisture resistance)	1,000	1,000
Dielectric withstanding voltage:		
Atmospheric pressure (volts)	4,500	4,500
Barometric pressure (volts)	1,000	1,000
Terminal strength:		
Torque (inch-pounds)	24	32
Direct pull (pounds)	10, +0 -1/2	10, +0 -1/2

1/ Based on .00175 inch nominal diameter wire.
2/ Where total resistance change is 1 percent or less, it shall be considered as ± (___ percent +0.05 ohm).

SECTION 200

RESISTORS, VARIABLE

SECTION 201

RESISTORS, VARIABLE, COMPOSITION

* STYLES RV2, RV4, RV6, AND 2RV7

(APPLICABLE SPECIFICATION: MIL-R-94)

1. SCOPE. This section covers composition, variable resistors. These resistors are suitable for rheostat or potentiometer applications where stability and high precision are not required, and are capable of withstanding acceleration, shock, and high-frequency vibration. They are most useful in circuitry where high resistance values and low power dissipation are encountered in controlling volume, bias, tone, voltage output, and pulse width. Composition, variable resistors are useful only up to the low radiofrequency ranges.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have a composition resistance element shaped in an arc, and a contact bearing uniformly thereon, so that a change of resistance is produced between the terminal of the contact and the terminal at either end of the resistance element when the operating shaft is turned. The construction of the element is usually one of two types; a molded type which is a one-piece unit containing the resistance material, terminals, face plate, and the bushing, or a composition-film type constructed by spraying or painting a film of carbon resistance material onto the surface of a prepared form. A heat bonding of the element and form is then performed. The element is then contained in an enclosure which provides for environmental and mechanical protection.

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 70°C, mounted on a 16 gage steel plate, 4 inches square. This mounting technique should be taken into consideration when the wattage is applied during specific applications. When considering these resistors for potentiometer applications, it is necessary to bear in mind the fact that the load current as well as the "bleeder" current will be flowing through a part of the resistor and will contribute to the heating effect.

2.1.3 Derating at high temperature. When a resistor is to be used where the surrounding temperature is higher than 70°C, it should be derated in accordance with figure 201-1.

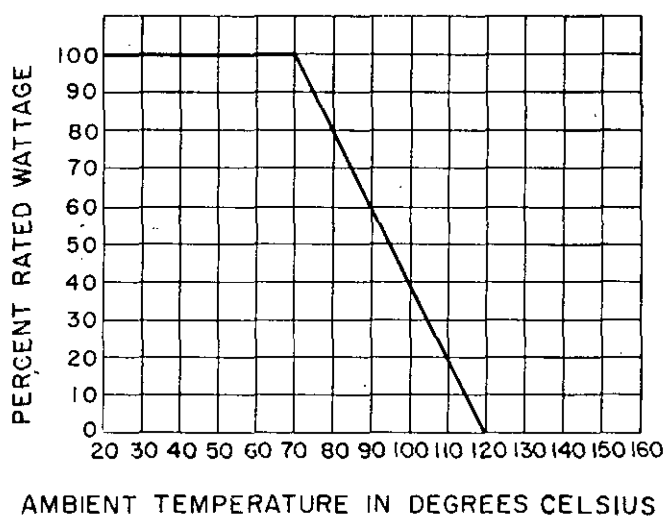


FIGURE 201-1. Derating curve for high ambient temperature.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating with optimum performance.

2.2 Soldering. Care should be taken in soldering resistors, since all properties of a composition resistor may be seriously affected when soldering irons are applied to terminals for too long a period.

2.3 Supplementary insulation. These variable resistors should not be used at potentials to ground greater than 500 volts peak, or 200 volts peak for aircraft equipment, unless supplementary insulation is provided.

2.4 Noise. The noise level is quite high compared to other types of resistors. Thermal and mechanical noise level will normally decrease with the life of the resistor.

* 3. ITEM IDENTIFICATION (see figures 201-2, 201-3, and 201-4).

* 3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figures 201-2 and 201-3.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 201-I.

* 3.3 Standard resistance values and rated continuous working voltages. The preferred standard resistance values and rated continuous working voltages (RCWV) are as follows:

Resistance value	RCWV 1/ (volts)		Resistance value	RCWV 1/ (volts)	
	Taper A	Taper C		Taper A	Taper C
STYLE RV2					
100Ω	10	7	20,000Ω 2/	140	100
150Ω	12	9	25,000Ω	158	112
200Ω 2/	14	10	35,000Ω	187	132
250Ω	16	11	50,000Ω	224	158
350Ω	19	13	75,000Ω	274	194
500Ω	22	16	.10 MΩ	316	200
750Ω	27	19	.15 MΩ	350	200
1,000Ω	32	24	.20 MΩ 2/	350	200
1,500Ω	39	27	.25 MΩ	350	200
2,000Ω 2/	44	31	.35 MΩ	350	200
2,500Ω	50	35	.50 MΩ	350	200
3,500Ω	59	42	.75 MΩ	350	200
5,000Ω	71	50	1.0 MΩ	350	200
7,500Ω	87	62	1.5 MΩ	350	200
10,000Ω	100	71	2.0 MΩ	350	200
15,000Ω	123	87	2.5 MΩ	350	200
STYLE RV4					
50Ω	10	---	50,000Ω	316	224
100Ω	14	10	.10 MΩ	445	316
250Ω	22	16	.25 MΩ	500	350
500Ω	32	23	.50 MΩ	500	350
1,000Ω	45	32	1.0 MΩ	500	350
2,500Ω	71	50	2.0 MΩ	500	350
5,000Ω	100	71	2.5 MΩ	500	350
10,000Ω	141	100	5.0 MΩ	500	350
25,000Ω	224	160			

See footnotes at end of table.

Resistance value	RCWV 1/ (volts) Taper A	RCWV 1/ (volts) Taper C	Resistance value	RCWV 1/ (volts) Taper A	RCWV 1/ (volts) Taper C
STYLE RV6					
100Ω	7	5	50,000Ω	158	112
250Ω	11	8	.10 MΩ	224	160
500Ω	16	11	.25 MΩ	350	200
1,000Ω	22	16	.50 MΩ	350	200
2,500Ω	35	25	1.0 MΩ	350	200
5,000Ω	50	36	2.0 MΩ	350	200
10,000Ω	71	50	2.5 MΩ	350	200
25,000Ω	112	80	5.0 MΩ	350	200

STYLE 2RV7

RCWV 3/ (volts)

Resistance characteristic combination A

Resistance value	Panel section	Rear section
50Ω	10	9
100Ω	14	13
150Ω	17	15
200Ω	20	18
250Ω	22	20
350Ω	26	24
500Ω	32	28
750Ω	39	35
1,000Ω	45	40
1,500Ω	55	49
2,000Ω	63	57
2,500Ω	71	63
3,500Ω	84	75
5,000Ω	100	89
7,500Ω	122	110
10,000Ω	141	126
15,000Ω	173	155
20,000Ω	200	179
25,000Ω	224	200
35,000Ω	264	237
50,000Ω	316	283
75,000Ω	387	346
.10 MΩ	445	400
.15 MΩ	500	490
.20 MΩ	500	500
.25 MΩ	500	500
.35 MΩ	500	500
.50 MΩ	500	500
.75 MΩ	500	500
1.0 MΩ	500	500
1.5 MΩ	500	500
2.0 MΩ	500	500
2.5 MΩ	500	500
3.5 MΩ	500	500
5.0 MΩ	500	500

1/ RCWV at 70°C.
2/ For replacement purposes only. Not for new design.
3/ Rated continuous working voltage at 70°C. These are maximum values that would apply only when the other section has zero wattage dissipated.

RV4 S A Y SA 500 A

STYLE: The two-letter symbol "RV" identifies composition, variable resistors; the single number identifies the size and power rating.

BUSHING: The single-letter symbol identifies the type of mounting bushing as follows:

* N - - Standard
* L - - Locking
S - - Shaft and panel seal (standard)
T - - Shaft and panel seal (locking)

SWITCH: The single-letter symbol "A" indicates the absence of a switch.

TEMPERATURE AND MOISTURE RESISTANCE CHARACTERISTIC: The single-letter symbol "Y" identifies the temperature (120°C maximum ambient temperature; 70°C maximum ambient temperature at rated wattage) and moisture resistance characteristic as follows:

ΔR due to moisture resistance change:
Average -- 6 percent
Maximum -- 10 percent
Insulation resistance - 100 megohms

OPERATING SHAFT: The two-letter symbol identifies the operating shaft. The first letter indicates either "S" for a slotted shaft or "F" for a flatted shaft; the second letter indicates the operating shaft length as follows:

A - - - 5/8 inch, screwdriver slot (locking bushing type T)
D - - - 7/8 inch, knob (standard bushing type S)
B - - - 1/2 inch, screwdriver slot (standard bushing type S, RV4 only)
L - - - 3/8 inch, screwdriver slot (standard bushing type S, RV6 only)

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:

500- - - - - 50 ohms
501- - - - - 500 ohms
502- - - - - 5,000 ohms

RESISTANCE CHARACTERISTIC: The single-letter symbol identifies the resistance characteristic as follows:

A - - - Taper A (linear CW), ±10 percent resistance tolerance
C - - - Taper C (10 percent CW) ±10 percent resistance tolerance

FIGURE 201-2. Type designation example.

2RV7 N Y SD 103 102 A

STYLE: The style is identified by a two-letter symbol "RV" preceded and followed by a one-digit number. The first number identifies a dual gauged (2 cup) resistor, the letters identify composition, variable resistors, and the last number identifies the size and power rating of both cups.

BUSHING: The type of bushing is identified by a single letter in accordance with MIL-R-94.

TEMPERATURE AND MOISTURE RESISTANCE CHARACTERISTIC: The temperature and moisture resistance characteristic is identified by a single letter in accordance with MIL-R-94.

OPERATING SHAFT: The operating shaft styles and lengths are identified by a two-letter symbol. The first letter indicates operating shaft style in accordance with MIL-R-94, and the second letter indicates operating shaft length as specified in table 201.I.

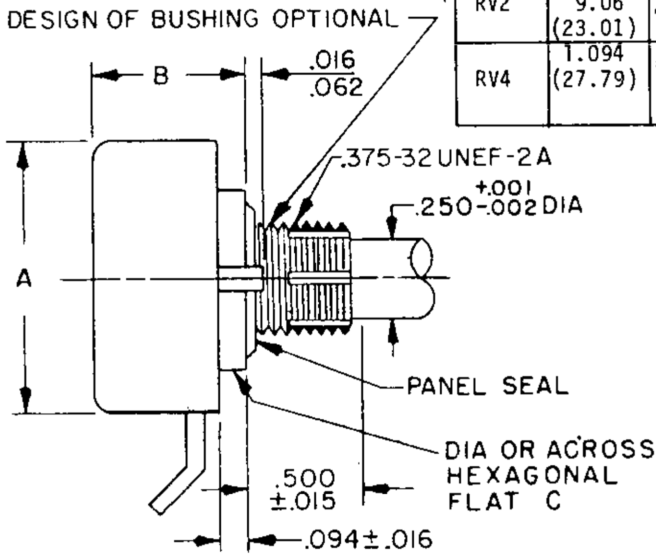
RESISTANCE: The nominal total resistance value expressed in ohms is identified by a three-digit number. The first two digits represent significant figures and the last digit specifies the number of zeros to follow. The first three digits in the type designation is the value of the resistor cup nearest the mounting surface and the next three digits is the resistance value of the second cup.

RESISTANCE CHARACTERISTIC COMBINATIONS: The resistance characteristic combination is identified by a single letter which describes a combination of resistance characteristic symbols per MIL-R-94, as follows.

Resistance characteristic combination symbol	Panel section	Rear section
	Resistance characteristic symbol	
A	A	A

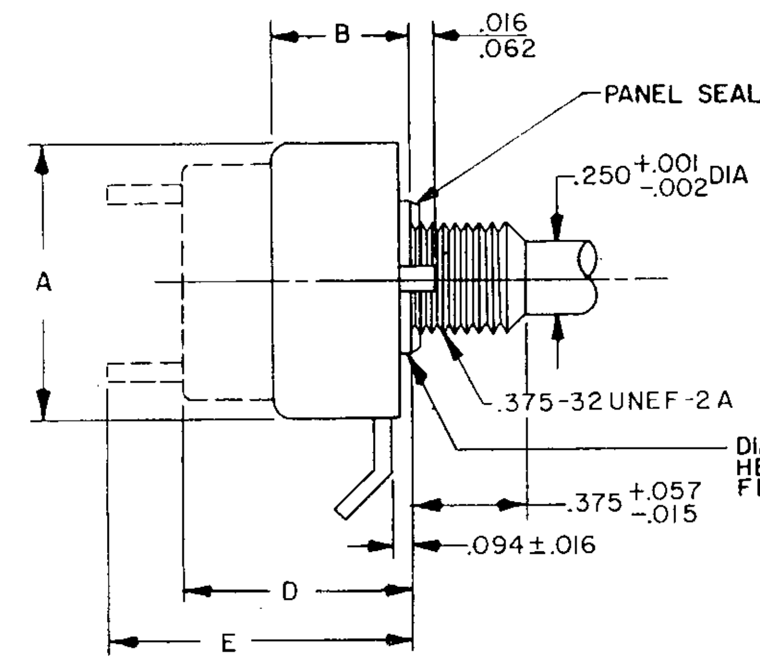
FIGURE 201-3. Type designation example.

Style	A	B	C	D	E
RV2	9.06 (23.01)	.500+.109 (12.70)	.625+.078 (15.88)	.797+.109 (20.24)	1.047+.172 (26.59)
RV4	1.094 (27.79)	.609+.141 (15.47)	.593+.045 (15.06)	.825+.141 (21.03)	1.031+.172 .125 (26.19)

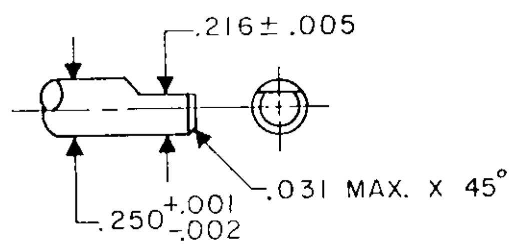


SHAFT-AND PANEL-SEALED-LOCKING BUSHING TYPE

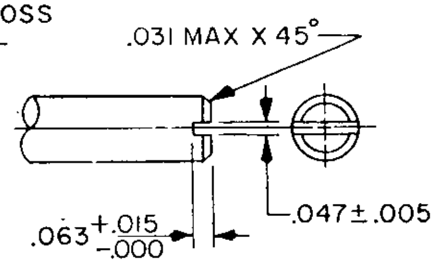
Inches	mm	Inches	mm	Inches	mm
.001	0.03	.063	1.60	.593	15.06
.002	0.05	.085	2.16	.609	15.47
.005	0.13	.094	2.39	.625	15.88
.015	0.38	.109	2.77	.697	17.70
.016	0.41	.125	3.18	.750	19.05
.031	0.79	.141	3.58	.797	20.24
.040	1.02	.172	4.37	.813	20.65
.045	1.14	.216	5.49	.823	21.03
.047	1.19	.250	6.35	.906	23.01
.050	1.27	.375	9.53	1.000	25.40
.057	1.45	.438	11.13	1.031	26.19
.062	1.57	.453	11.51	1.047	26.59



SHAFT-AND PANEL-SEALED-STANDARD BUSHING TYPE



FLATTED SHAFT

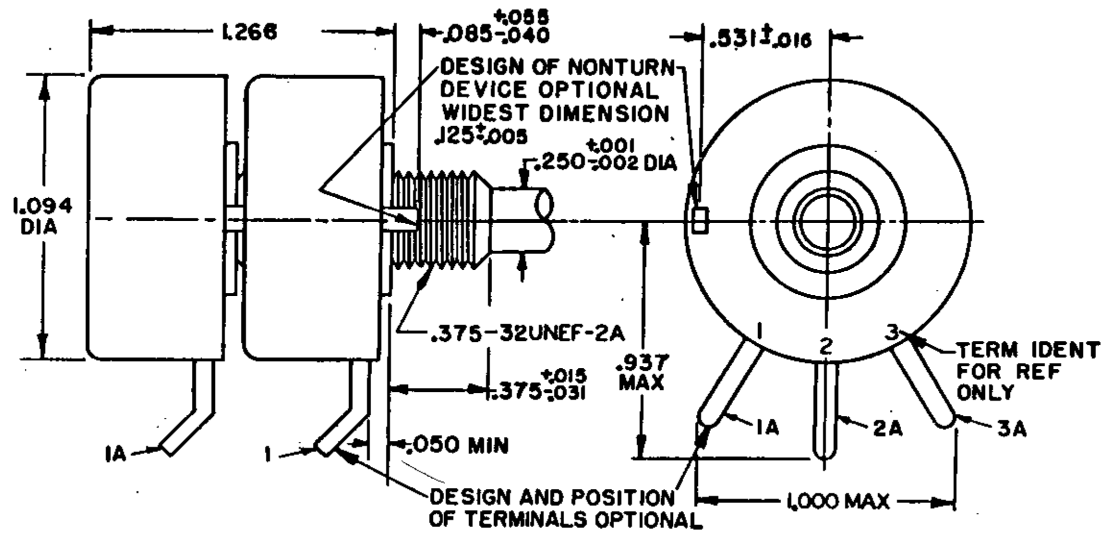


SLOTTED SHAFT

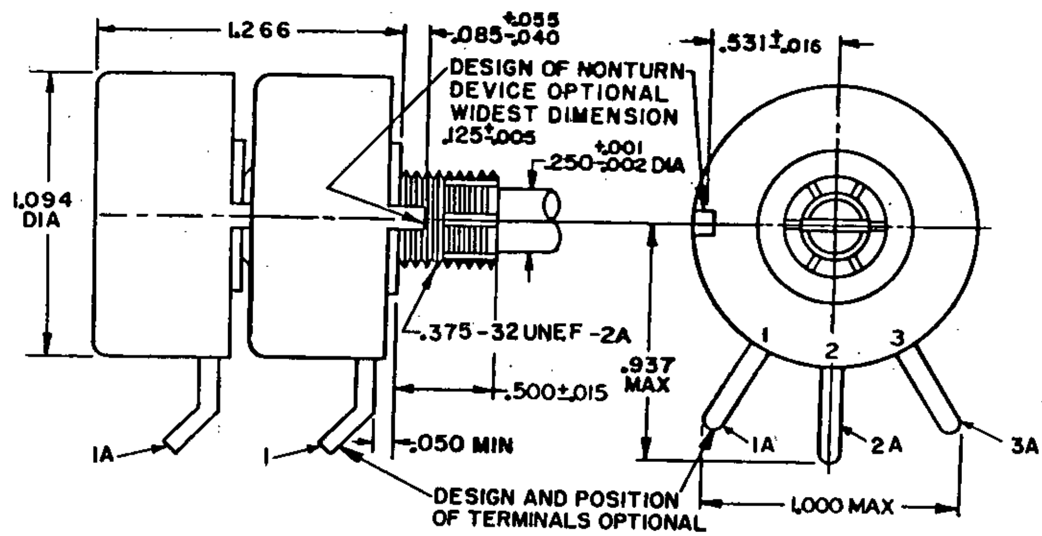
NOTE: Unless otherwise specified, tolerance is +.062 (1.57 mm).

FIGURE 201-4. Composition, variable resistors.

STYLE 2RV7



STANDARD-BUSHING TYPE



LOCKING-BUSHING TYPE

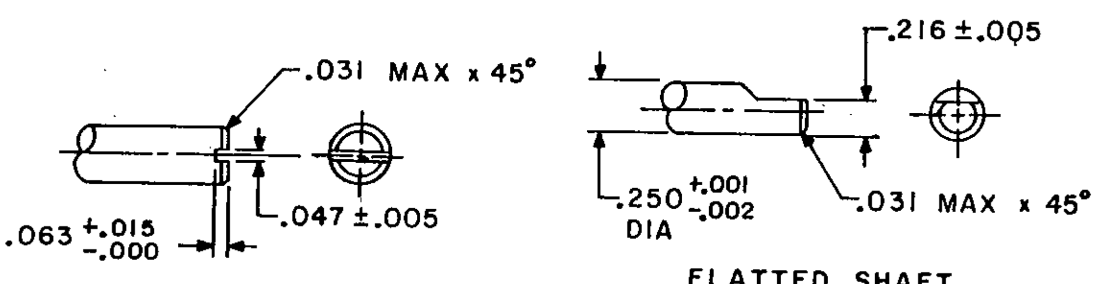
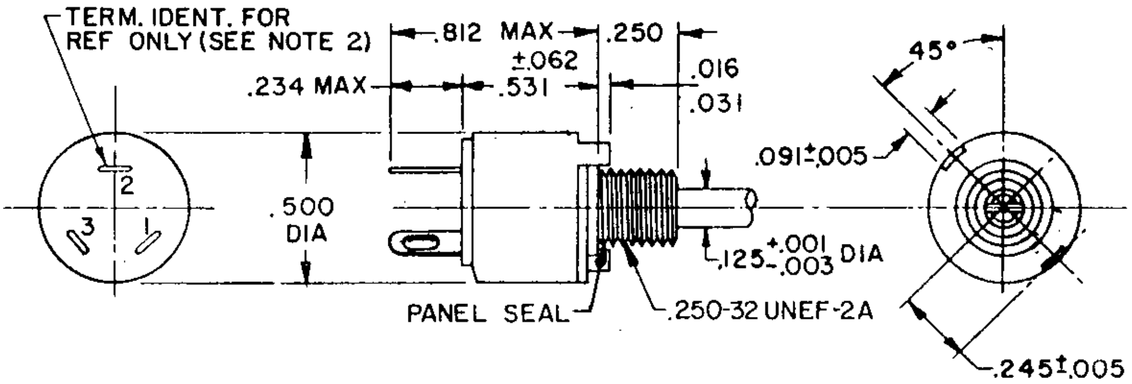
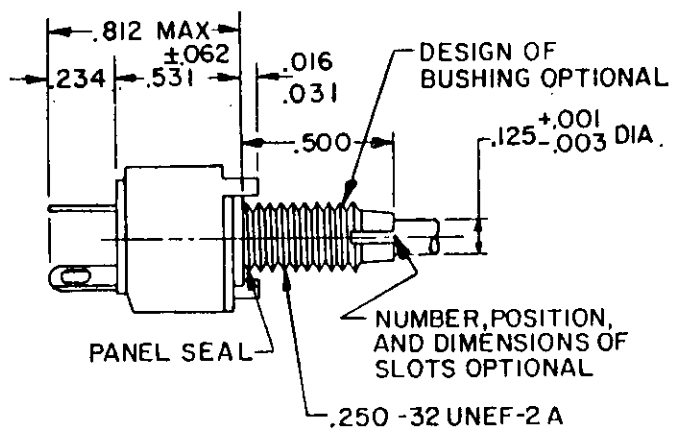


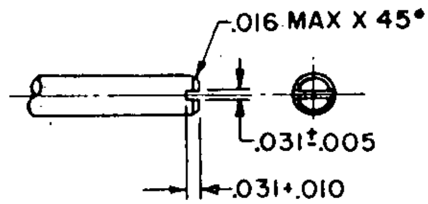
FIGURE 201-4. Composition, variable resistors - Continued.

STYLE RV6



SHAFT-AND PANEL-SEALED-STANDARD BUSHING TYPE

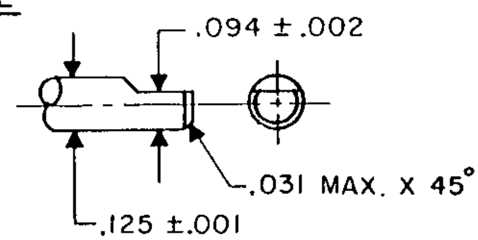




SLOTTED SHAFT

SHAFT-AND PANEL-SEALED- LOCKING BUSHING TYPE

Inches	mm	Inches	mm	Inches	mm
.001	.03	.031	.79	.245	6.22
.002	.05	.062	1.57	.250	6.35
.003	.08	.091	2.31	.500	12.70
.005	.13	.094	2.39	.531	13.49
.010	.25	.125	3.18	.812	20.62
.016	.41	.234	5.94		



FLATTED SHAFT

NOTES:
1. Unless otherwise specified, tolerance is ±.016 (.41 mm).
2. When terminals are located symmetrically, the contact terminal is identified on the unit. The identifying mark is at the option of the supplier.

FIGURE 201-4. Composition, variable resistors - Continued.

3.4 Linear and nonlinear tapers. Taper A is a linear resistance taper, which is one having a constant change of resistance with angular rotation, while taper C is a nonlinear resistance taper, which has a variation or lack of constancy in the change of resistance with angular rotation. (See figure 201-5.)

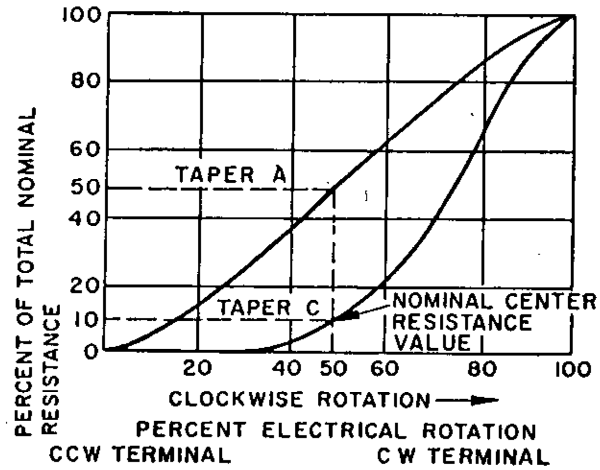


FIGURE 201-5. Clockwise taper.

3.5 Shelf life. An average resistance change (ΔR) of 20 percent per year under normal storage conditions is estimated.

3.6 Temperature characteristic. An average change of ±8 percent due to thermal cycling is estimated.

TABLE 201-I. Performance characteristics.

Features	Style RV2	Style RV4	Style RV6	Style 2RV7
Type bushing	Shaft and panel seal (S); Shaft and panel seal, locking (T)	Shaft and panel seal (S); Shaft and panel seal, locking (T)	Same as RV4	Same as RV4
Switch	None	None	None	None
Style shaft Length	Slotted 5/8 inch (T bushing); 1/2 and 7/8 inch (S bushing)	Slotted 5/8 inch (T bushing); 1/2 and 7/8 inch (S bushing)	Slotted 5/8 inch (T bushing); 3/8 and 7/8 inch (S bushing)	Slotted 5/8 inch (T bushing); 1/2 and 7/8 inch (S bushing)
Style shaft Length	Flatted 7/8 inch (S bushing)	Flatted 7/8 inch (S bushing)	Flatted 7/8 inch (S bushing)	Flatted 7/8 inch (S bushing)
Minimum resistance, ohms:				
Taper A (linear)	100	50	100	50
Taper C (10 percent CW)	100	100	100	50
Maximum resistance, megohms:				
Taper A (linear)	2.5	5	5	5
Taper C (10 percent CW)	2.5	5	5	5
Resistance characteristic	10 percent resistance tolerance with linear taper (A) and 10 percent resistance tolerance with 10 percent CW taper (C)	10 percent resistance tolerance with linear taper (A) and 10 percent resistance tolerance with 10 percent CW taper (C)	Same as RV4	Same as RV4
Power rating, watts (at 70°C):				
Taper A (linear)	1	2	1/2	3-2 (panel), 1.5-0 (rear) taper A only
Taper C (10 percent CW)	1/2	1	1/4	
Torque:				
Operating	1 inch-ounce min; 6 inch-ounces max	1 inch-ounce min; 6 inch-ounces max	.5 inch-ounce min; 6 inch-ounces max	Same as RV4
Stopping	8 inch-pounds	8 inch-pounds	3 inch-pounds	Same as RV4
Total mechanical rotation, degrees: Without switch	251 to 318	309 to 320	292 to 298	309 to 320
Electrical rotation, degrees: Without switch	251 to 318	309 to 320	292 to 298	309 to 320
Resistant to moisture	Yes	Yes	Yes	Yes
Rotational life	25,000 cycles (S) bushing 500 cycles (T) bushing	25,000 cycles (S) bushing 500 cycles (T) bushing	Same as RV4 Same as RV4	Same as RV4 Same as RV4
Max percent change in resistance (*):				
Load life (1,000 hr)	10 percent	10 percent	10 percent	10 percent
Low temperature operation	3 percent	3 percent; 48 inch-ounces torque	3 percent; 30 inch-ounces torque	3 percent
Low temperature storage	2 percent	2 percent	2 percent	2 percent
Vibration (low frequency)	2 percent	2 percent	2 percent	2 percent
Shock	2 percent	2 percent	2 percent	2 percent
Vibration (high frequency)	2 percent	2 percent	2 percent	2 percent
Moisture resistance	IR = 100 megohms; no mechanical damage	IR = 100 megohms; no mechanical damage	Same as RV4	Same as RV4
Effect of soldering Dielectric strength	No mechanical or electrical damage	No mechanical or electrical damage	Same as RV4	Same as RV4
Salt spray	Mechanically operative	Mechanically operative	Same as RV4	Same as RV4

SECTION 202

RESISTORS, VARIABLE, WIREWOUND (LOW OPERATING TEMPERATURE)

STYLES RA20 AND RA30

(APPLICABLE SPECIFICATION: MIL-R-19)

1. SCOPE. This section covers low-operating temperature, wirewound, variable resistors. These resistors are designed primarily for noncritical, low-power uses where the characteristics of wirewound resistors are more desirable than those of composition. They have a hot-spot temperature of 105°C for continuous duty and may be used as bias controls and voltage dividers in test instruments, bridge circuits, etc. Designers are cautioned to give consideration to the frequency in such circuits where the inductance effects of these resistors might be undesirable.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have a resistance element of continuous length wire, wound on an insulating strip or core and shaped in an arc so that a contact bears uniformly on the resistance element when adjusted by a control shaft. Various functions are available as indicated on figure 202-2. The contact is insulated from the operating shaft and the resistor housing. The housing provides mechanical and environmental protection of the element.

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 40°C, mounted on a 16-gauge steel plate, 4 inches square. This mounting technique should be taken into consideration when the wattage is applied during specific applications. When considering these resistors for potentiometer applications, it is necessary to bear in mind the fact that the lead current as well as the "bleeder" current will be flowing through a part of the resistor and will contribute to the heating effect.

2.1.3 Nominal current rating. The nominal maximum current rating of these resistors is as shown in table 202-I.

TABLE 202-I. Maximum permissible current.

Taper	Maximum permissible current	
	High-resistance section	Low-resistance section
Linear (A) - - - - -	$\sqrt{W/R}$	---
Taper (C)- - - - - -	$0.745\sqrt{W/R}$	$2.24\sqrt{W/R}$

W = Rated nominal wattage for linear taper A resistors.

R = Nominal total resistance.

2.1.4 Derating at high temperatures. When a resistor is to be used in a circuit where the surrounding temperature is higher than 40°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the curve shown on figure 202-1. It should be noted that the continuous wattage rating for linear types is directly proportional to the amount of resistance element in the circuit.

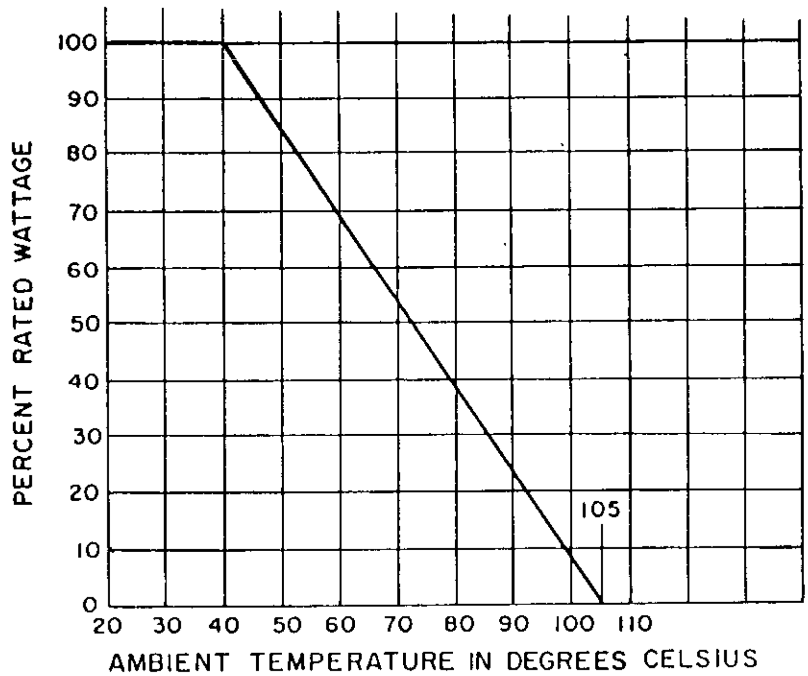


FIGURE 202-1. Derating curve for continuous duty.

2.1.5 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating, with optimum performance.

3. ITEM IDENTIFICATION (see figures 202-2 and 202-3).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 202-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 202-II.

3.3 Preferred resistance values. The preferred nominal total resistance values are as follows:

Ohms	Ohms	Ohms	Ohms
3	35	350	3,500
6	50	500	5,000
8	75	750	7,500
10	100	1,000	10,000
15	150	1,500	15,000
20	200	2,000	*20,000
25	250	2,500	*25,000

* Applicable to RA30 only. (See table 202-II for minimum and maximum resistance values available in taper C.)

RA20 T A SA 3R0 A

STYLE: The two-letter symbol "RA" identifies wirewound, variable resistors; the two-digit number identifies the size and power rating.

BUSHING: The single-letter symbol identifies the type of mounting bushing as follows:

T - - Locking bushing, shaft and panel seal
S - - Standard bushing, shaft and panel seal

SWITCH: The single-letter symbol "A" indicates the absence of a switch.

OPERATING SHAFT: The two-letter symbol identifies the operating shaft. The first letter "S" indicates a slotted shaft; the second letter indicates the operating shaft length as follows:

B - - - 5/8 inch, screwdriver slotted (locking bushing type T)
D - - - 7/8 inch, knob (standard bushing type S)
A - - - 1/2 inch, screwdriver slotted (standard bushing type S)

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 10 ohms, the letter "R" represents the decimal point. (See 3.3 and the following example.)

EXAMPLE:

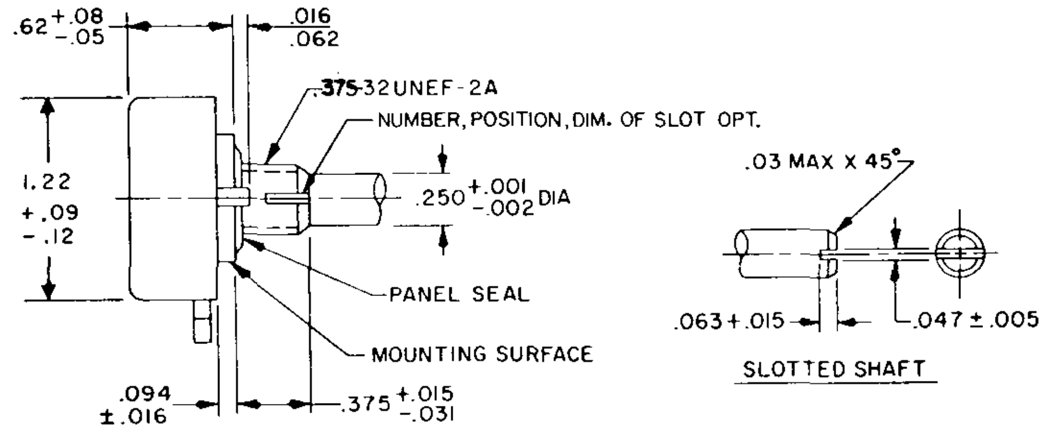
3R0- - - - - 3.0 ohms
100- - - - - 10 ohms
101- - - - - 100 ohms

RESISTANCE CHARACTERISTIC: The single-letter symbol identifies the resistance characteristic as follows:

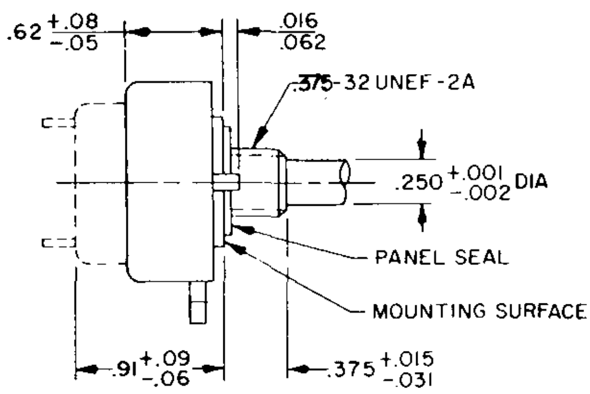
A - - - Taper A (linear CW), ±10 percent resistance tolerance
C - - - Taper C (10 percent CW) ±10 percent resistance tolerance

FIGURE 202-2. Type designation example.

STYLE RA20



SHAFT-AND PANEL-SEALED LOCKING BUSHING TYPE

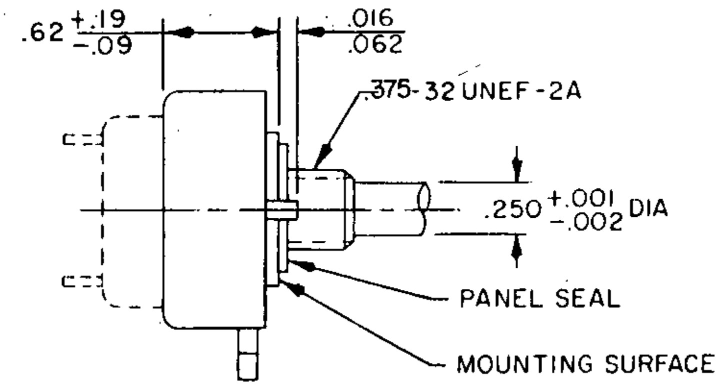


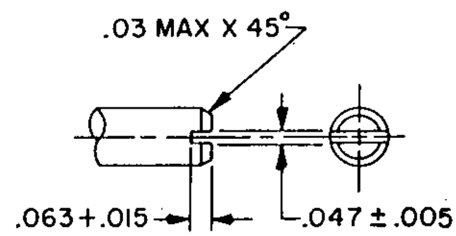
SHAFT-AND PANEL-SEAL TYPE, STANDARD BUSHING

Inches	mm	Inches	mm
.001	.03	.063	1.60
.002	.05	.09	2.29
.005	.13	.094	2.39
.015	.38	.12	3.05
.016	.41	.19	4.83
.03	.76	.250	6.35
.047	1.19	.500	12.70
.062	1.57	.62	15.75
		1.22	31.35

FIGURE 202-3. Wirewound (low operating temperature), variable resistors.

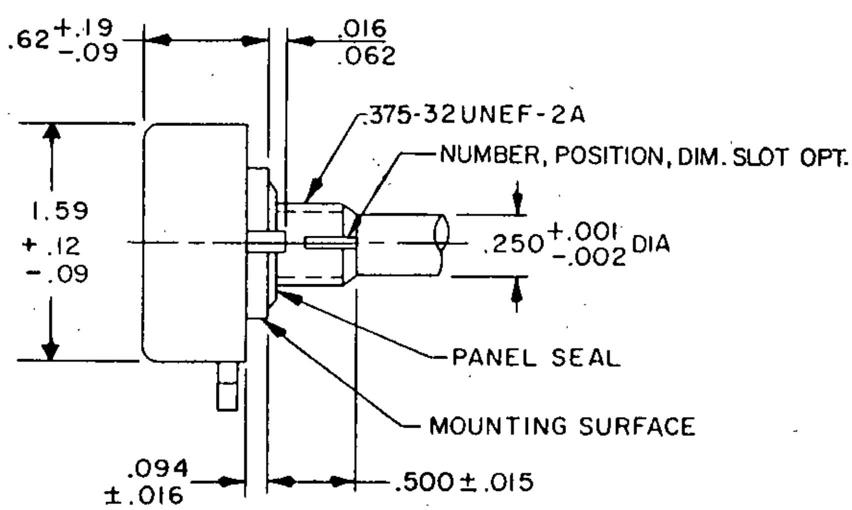
STYLE RA30





SLOTTED SHAFT

SHAFT-AND PANEL-SEAL TYPE STANDARD BUSHING



Inches	mm	Inches	mm
.001	.03	.062	1.57
.002	.05	.063	1.60
.005	.13	.08	2.03
.015	.38	.09	2.29
.016	.41	.094	2.39
.03	.76	.12	3.05
.031	.79	.250	6.35
.047	1.19	.375	9.53
.05	1.27	.62	15.75
.06	1.52	.91	23.11
		1.59	40.39

SHAFT-AND PANEL-SEALED LOCKING BUSHING TYPE

FIGURE 202-3. Wirewound (low operating temperature), variable resistors - Continued

3.4 Linear and nonlinear tapers. Taper A is a linear resistance taper, which is one having a constant change of resistance with angular rotation, while taper C is a nonlinear resistance taper, which has a variation or lack of constancy in the change of resistance with angular rotation. (See figure 202-4.)

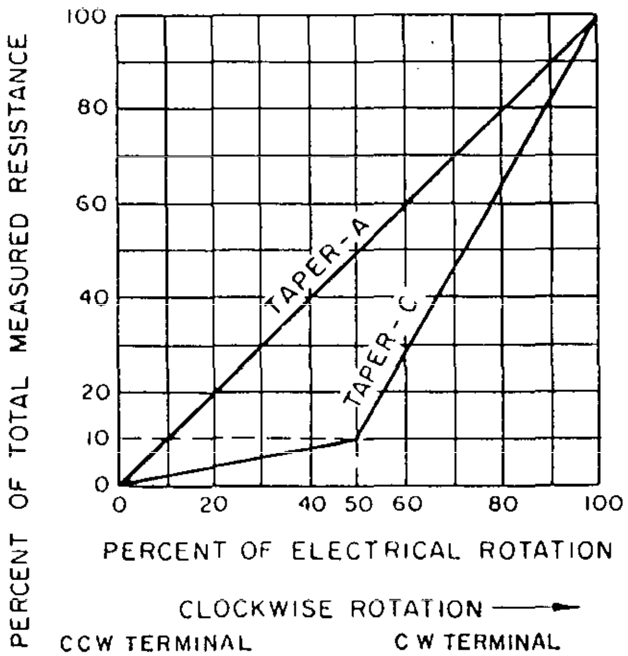


FIGURE 202-4. Clockwise tapers.

TABLE 202-II. Performance characteristics.

Features	Style RA20	Style RA30
Type bushing and symbol	Shaft and panel seal; standard (S), locking (T)	Same as RA20
Switch	None	None
Style shaft	Slotted	Same as RA20
Length	5/8 inch (locking bushing) 1/2 and 7/8 (shaft and panel seal)	Same as RA20
Minimum resistance (ohms):		
Taper A (linear)	3	3
Taper C (10 percent CW)	10	10
Maximum resistance (ohms):		
Taper A (linear)	15,000	25,000
Taper C (10 percent CW)	5,000	7,000
Resistance characteristic	10 percent resistance tolerance with linear taper (A) and 10 percent resistance tolerance with 10 percent CW taper (C)	Same as RA20
Power rating (watts) (at 40°C):		
Taper A (linear)	2.0	4.0
Taper C (10 percent CW)	1.1	2.2
Total mechanical rotation, degrees:		
Without switch	290 to 305	280 to 305
Electrical rotation, degrees:		
Without switch	290 to 305	280 to 305
Resistant to moisture	Yes	Yes
Dielectric withstanding voltage	No breakdown, arcing, or mechanical damage. Leakage current not in excess of 10 milliamperes.	Same as RA20
Maximum percent change in resistance:		
Low-temperature storage	4 percent	4 percent
Low-temperature operation	4 percent; 40 inch-ounces (torque)	4 percent; 40 inch-ounces
Temperature cycling	4 percent. No mechanical damage.	4 percent. No mechanical damage.
Load life	3 percent	3 percent
Moisture resistance	10 percent	10 percent
Rotational life (full load):		
25,000 cycles - S-bushing	5 percent	5 percent
500 cycles - T-bushing	5 percent	5 percent
Shock	2 percent. No mechanical damage.	2 percent. No mechanical damage.
Vibration	2 percent. No mechanical damage.	2 percent. No mechanical damage.
Insulation resistance (min) (megohms):		
Dry	100	100
Wet (after moisture resistance)	3.5	3.5
Salt spray	No mechanical or electrical damage	Same as RA20

SECTION 203

RESISTORS, VARIABLE (WIREWOUND, POWER TYPE)

STYLES RP05, RP06, RP10, RP15, RP20, RP25, AND RP30 (UNENCLOSED)

(APPLICABLE SPECIFICATION: MIL-R-22)

1. SCOPE. Resistors covered by this section are particularly adaptable to such applications as motor speed controls; generator field controls; lamp dimming; heater and oven controls; potentiometer uses; and applications where variation of voltage or current is required (such as voltage-divider and "bleeder" circuits).

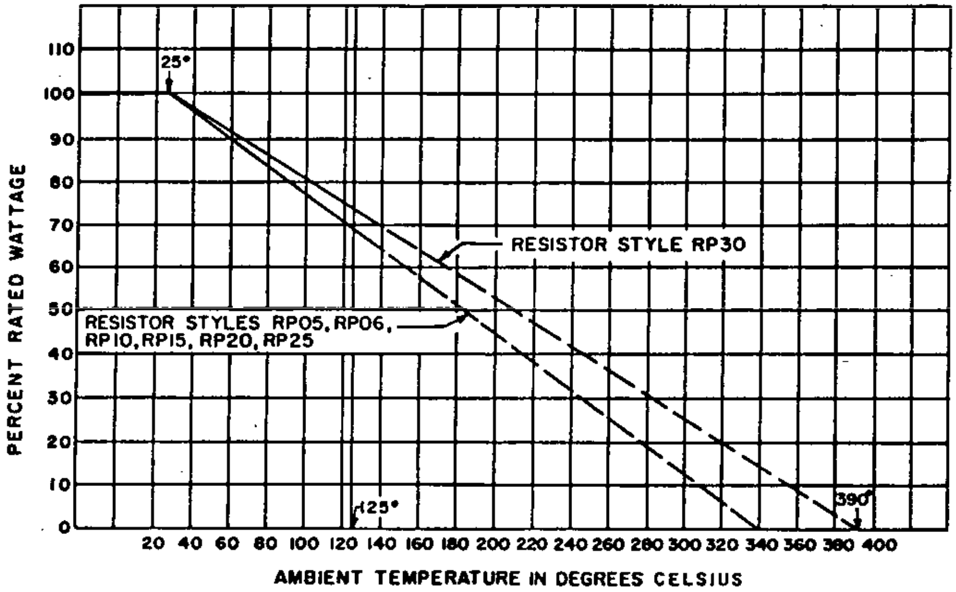
2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have a resistance element of wire, wound on an insulating core and shaped in an arc. The wire and core are usually bonded to the base structure by a vitreous enamel. A contact arm bears uniformly on the resistance element when adjusted by a control shaft. Rotation is limited by stop, and electrical off positions are available. All styles in this section are classified as "unenclosed."

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 25°C, mounted on a 12-inch square steel panel, .063 inch thick (4 inch square x .050 for RP05 and RP06). This mounting technique should be taken into consideration when the wattage is applied during specific applications. When considering these resistors for potentiometer applications, it is necessary to bear in mind the fact that load current as well as the "bleeder" current will be flowing through a part of the resistor and will contribute to the heating effect.

2.1.3 Derating at high temperature. These resistors may be used at the full nominal wattage at an ambient temperature of 25°C. When a resistor is to be used where the surrounding temperature is higher than 25°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the curve shown on figure 203-1.



NOTE: Operation of these resistors at ambient temperatures greater than 125°C can damage the metal plating, the shaft lubricant, the insulation, etc., of the resistors.

FIGURE 203-1. Power-rating curves for continuous duty.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating.

2.2 Supplementary insulation. These resistors should not be used at potentials above ground greater than 500 volts (250 volts for styles RP05 and RP06) unless supplementary insulation is used.

2.3 Electrical off position. Care should be exercised in specifying an electrical off position when resistors are required to break dc circuits having potentials in excess of 40 volts.

2.4 Nominal maximum current rating. The nominal maximum current rating of resistors is given as follows:

$$I = \sqrt{\frac{W}{R}}$$

Where:

I = Nominal maximum current rating

W = Nominal wattage (entire element)

R = Nominal total resistance

The maximum current shall not be exceeded on any portion of the winding, under any conditions.

3. ITEM IDENTIFICATION (see figures 203-2 through 203-4).

3.1 Part number. The part number is used for identifying the resistor as shown in figure 203-2.

3.2 Type designation. The type designation is used for describing the resistor as shown in figure 203-3.

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in table 203-I.

3.4 Preferred resistance values. The preferred nominal total resistance values are as follows:

Ohms	Ohms	Ohms
1.0 (RP06 and RP15)	15.0	500
	25.0	1,000
	35.0	1,500
2.0	50.0	2,500
2.5	100	3,500
6.0	200	5,000*
8.0	350	10,000

* Maximum value RP05.

NOTE: See table 203-I for minimum and maximum values applicable to each style.

M22/05 - 0001 1 S A

SPECIFICATION NUMBER: The number identifies the detail specification number (indicating MIL-R-22/5).

DASH NUMBER: The applicable dash number is as indicated in figure 203-4.

ELECTRICAL OFF POSITION: The single-digit number identifies the electrical off position as follows:

1 - - - No electrical off position

2 - - - Electrical off position at end of rotation of control knob in a CCW direction

3 - - - Electrical off position at end of rotation of control knob in a CW direction

SHAFT STYLE AND TYPE OF MOUNTING: The single-letter symbol identifies the style (slotted shaft) and type of mounting, as follows:

S - - - Standard bushing
U - - - Locking bushing

SHAFT LENGTH: The single-letter symbol identifies the length of the operating shaft (±3/64 inch) as follows:

A - - - 1/2 inch, standard bushing (RP10, RP15, RP20, RP25, and RP30)
B - - - 5/8 inch, standard bushing (RP05 and RP06); and locking bushing (RP05, RP06, RP10, RP15, RP20, RP25, and RP30)
D - - - 7/8 inch, locking bushing (RP05); and standard bushing (RP10, RP15, RP20, RP25, and RP30)
J - - - 2 inch, standard bushing (RP06, RP10, RP15, RP20, RP25, and RP30)
S - - - 3/8 inch, standard bushing (RP06)

FIGURE 203-2. Part number example.

RP05 - 1 SB 100 KK

STYLE: The two-letter symbol "RP" identifies power type, wirewound, variable resistors; the two-digit number identifies the size and power rating

ELECTRICAL OFF POSITION: The single digit number indicates the existence and location of an electrical off position at one end of the resistance element as follows:

1 - - - No electrical off position

2 - - - Electrical off position at end of rotation of control knob in a CCW direction

3 - - - Electrical off position at end of rotation of control knob in a CW direction

SHAFT AND TYPE OF MOUNTING: The two-letter symbol identifies the shaft style, type of mounting, and shaft length. The first letter indicates the style (slotted) and type of mounting ("S" standard bushing and "U" locking bushing). The second letter identifies the length of the operating shaft as follows:

A - - - 1/2 inch, standard bushing (RP10, RP15, RP20, RP25, and RP30)
B - - - 5/8 inch, standard bushing (RP05 and RP06); and locking bushing (RP05, RP06, RP10, RP15, RP20, RP25, and RP30)
D - - - 7/8 inch, locking bushing (RP05); and standard bushing (RP10, RP15, RP20, RP25, and RP30)
J - - - 2 inch, standard bushing (RP06, RP10, RP15, RP20, RP25, and RP30)
S - - - 3/8 inch, standard bushing (RP06)

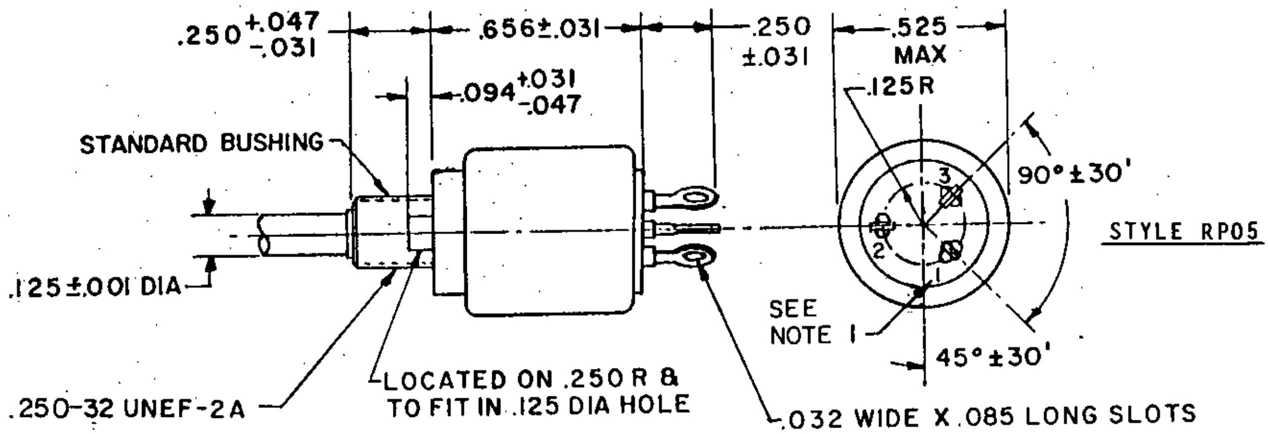
RESISTANCE: The three-digit number identifies the nominal total resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 10 ohms, the letter "R" represents the decimal point. (See 3.4 and the following example):

EXAMPLE:

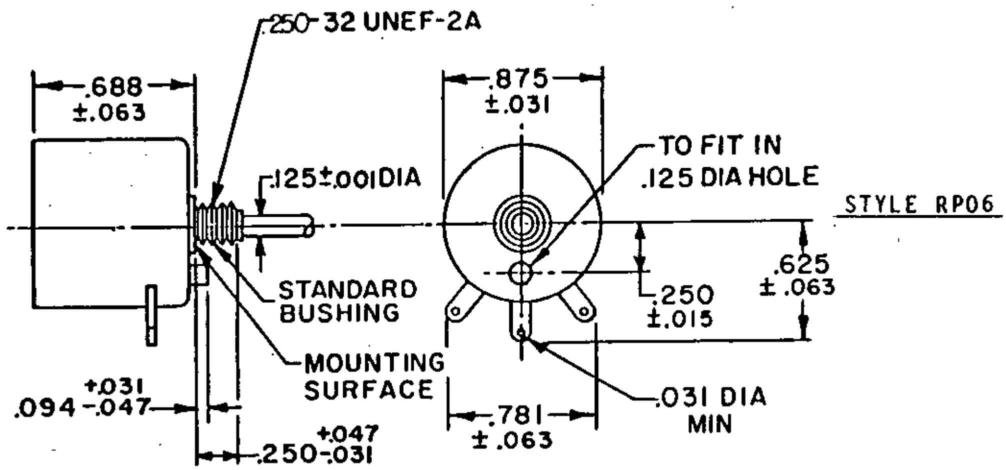
1R0 - - - - 1.0 ohm
100 - - - - 10 ohms
101 - - - - 100 ohms

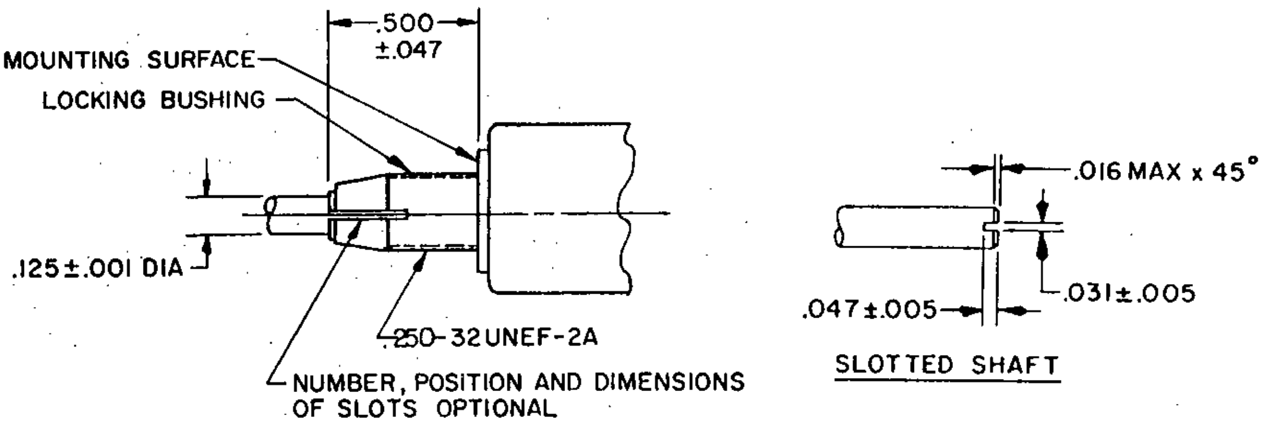
RESISTANCE TOLERANCE: The two-letter symbol "KK" identifies a resistance tolerance of ±10 percent.

FIGURE 203-3. Type designation example.



Inches	mm
.001	.03
.005	.13
.015	.38
.016	.41
.031	.79
.032	.81
.047	1.19
.063	1.60
.085	2.16
.094	2.39
.125	3.18
.250	6.35
.500	12.70
.525	13.34
.625	15.88
.656	16.66
.688	17.48
.781	19.84
.875	22.23





NOTES:
1. Terminal identification is for reference only.
2. These styles are supplied with one 1/4-32 UNEF-2B corrosion-resistant, hexagonal mounting nut having a nominal thickness of .062 (1.57 mm) and measuring .312 (7.92 mm) across the hexagonal flats; and one corrosion-resistant, internal-tooth lockwasher having an outside nominal diameter of .402 (10.21 mm), inside nominal diameter of .262 (6.65 mm), and a nominal thickness of .013 (.33 mm). The locking nut for the locking-bushing type is .156 (3.96 mm) thick, and measuring .312 (7.92 mm) across the hexagonal flats; the thread size is 1/4-32 UNEF-2B.

FIGURE 203-4. Wirewound, variable resistors (power type).

STYLE RP05

Part number 1/	Nominal total resistance value (ohms)	Maximum current (amperes)	Type designation 1/ (for reference only)
M22/15-0001---	10	.707	RP05---100KK
M22/15-0002---	15	.583	RP05---150KK
M22/15-0003---	25	.447	RP05---250KK
M22/15-0004---	35	.374	RP05---350KK
M22/15-0005---	50	.316	RP05---500KK
M22/15-0006---	75	.264	RP05---750KK
M22/15-0007---	100	.223	RP05---101KK
M22/15-0008---	150	.182	RP05---151KK
M22/15-0009---	200	.158	RP05---201KK
M22/15-0010---	250	.141	RP05---251KK
M22/15-0011---	350	.118	RP05---351KK
M22/15-0012---	500	.1	RP05---501KK
M22/15-0013---	750	.082	RP05---751KK
M22/15-0014---	1,000	.071	RP05---102KK
M22/15-0015---	1,500 2/	.056	RP05---152KK
M22/15-0016---	2,500 2/	.045	RP05---252KK
M22/15-0017---	3,500 2/	.037	RP05---352KK
M22/15-0018---	5,000 2/	.032	RP05---502KK

STYLE RP06

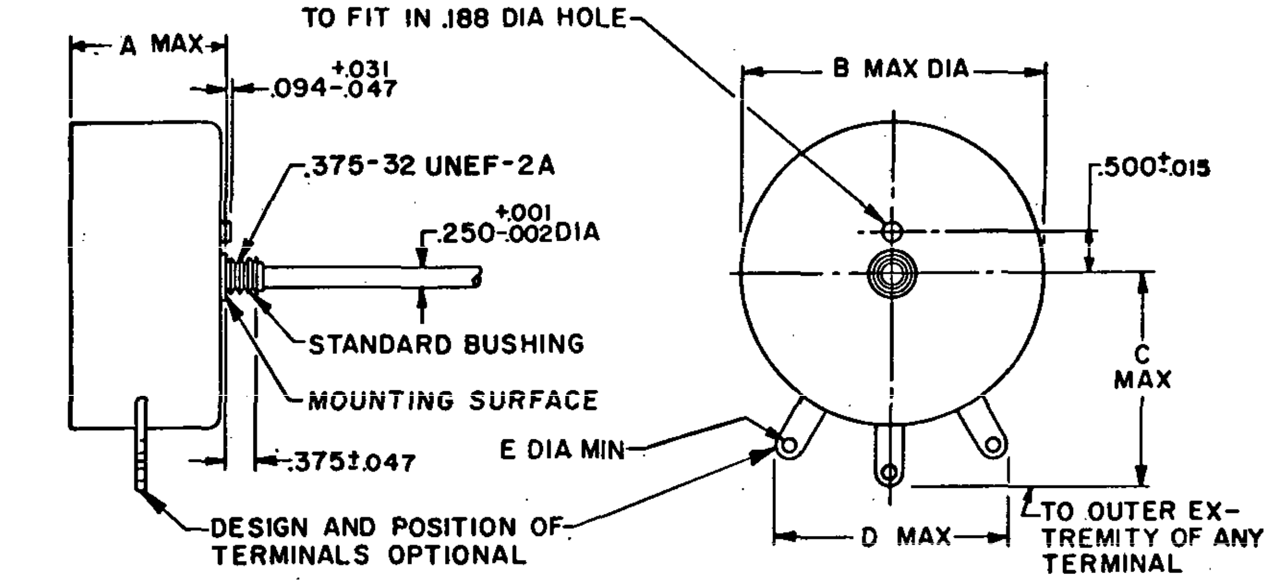
Part number 1/	Nominal total resistance value (ohms)	Maximum current (amperes)	Type designation 1/ (for reference only)
M22/01-0001---	1.0	3.53	RP06---1R0KK
M22/01-0002---	2.0	2.50	RP06---2R0KK
M22/01-0003---	2.5	2.23	RP06---2R5KK
M22/01-0004---	3.0	2.04	RP06---3R0KK
M22/01-0005---	5.0	1.58	RP06---5R0KK
M22/01-0006---	6.0	1.44	RP06---6R0KK
M22/01-0007---	8.0	1.25	RP06---8R0KK
M22/01-0008---	10	1.12	RP06---100KK
M22/01-0009---	15	0.91	RP06---150KK
M22/01-0010---	25	0.71	RP06---250KK
M22/01-0011---	35	0.62	RP06---350KK
M22/01-0012---	50	0.50	RP06---500KK
M22/01-0013---	75	0.41	RP06---750KK
M22/01-0014---	100	0.35	RP06---101KK
M22/01-0015---	150	0.29	RP06---151KK
M22/01-0016---	200	0.25	RP06---201KK
M22/01-0017---	250	0.22	RP06---251KK
M22/01-0018---	350	0.19	RP06---351KK
M22/01-0019---	500	0.16	RP06---501KK
M22/01-0020---	750	0.13	RP06---751KK
M22/01-0021---	1,000	0.11	RP06---102KK
M22/01-0022---	1,500	0.091	RP06---152KK
M22/01-0023---	2,500	0.071	RP06---252KK
M22/01-0024---	3,500	0.060	RP06---352KK

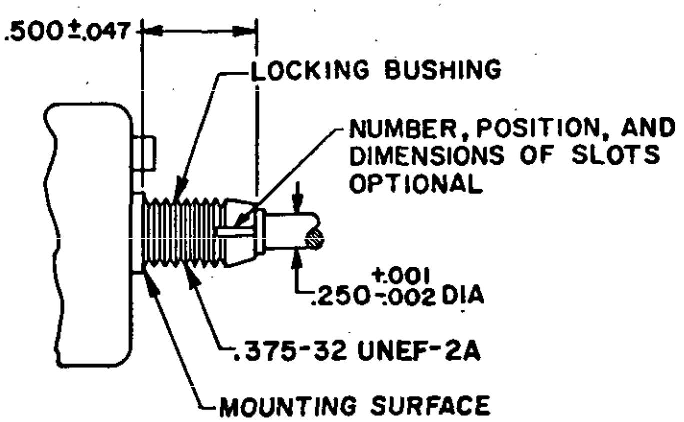
1/ The complete part number (and type designation) includes symbols indicating electrical off position, style of shaft and type of mounting, and length of operating shaft (see figure 203-2 for part number and 203-3 for type designation).

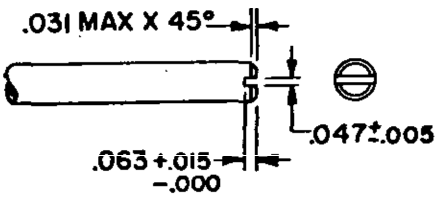
2/ Values based on use of wire size smaller than .0025 inch but not less than .0014 inch.

FIGURE 203-4. Wirewound, variable resistors (power type) - Continued.

STYLES RP10, RP15, RP20, RP25, AND RP30







SLOTTED SHAFT

Standard style	Dimension (inches)				
	A max	B max	C max	D max	E
RP10	1.410	1.680	1.420	1.880	.080
RP15	1.440	2.410	2.000	2.500	.138
RP20	1.780	2.810	1.820	2.560	*
RP25	1.780	3.190	2.190	2.690	*
RP30	2.030	4.060	2.440	3.000	*

* To clear No. 8 screw.

Inches	mm	Inches	mm
.001	.03	1.440	36.58
.002	.05	1.680	42.67
.005	.13	1.780	45.21
.015	.38	1.820	46.23
.031	.79	1.880	47.75
.047	1.19	2.000	50.80
.063	1.60	2.030	51.56
.080	2.03	2.190	55.63
.094	2.39	2.410	61.21
.125	3.18	2.440	61.98
.138	3.51	2.500	63.50
.188	4.78	2.560	65.02
.250	6.35	2.690	68.33
.375	9.53	2.810	71.37
.500	12.70	3.000	76.20
1.410	35.81	3.190	81.03
1.420	36.07	4.060	103.12

NOTE: These styles are supplied with one 3/8-32 UNEF-2B corrosion-resistant, hexagonal mounting nut having a nominal thickness of .094 inch (2.39 mm) and measuring .562 inch (14.27 mm) across the hexagonal flats, and one internal-tooth lockwasher in accordance with MS35333-76. The locking nut for locking-bushing type resistors is .151 inch (3.84 mm) to .234 inch (5.94 mm) thick, .500 inch (12.70 mm) across the hexagonal flats; thread size is 3/8-32 UNEF-2B.

FIGURE 203-4. Wirewound, variable resistors (power type) - Continued.

STYLES RP10, RP15, AND RP20

Part number 1/			Nominal total resistance value (ohms)	Maximum current (amperes)			Type designation 1/		
Style RP10	Style RP15	Style RP20		Style RP10	Style RP15	Style RP20	Style RP10	Style RP15	Style RP20
M22/03-	M22/05-	M22/07-					RP10---	RP15---	RP20---
0025---	0001---	---	1.0	5.00	7.07	---	1R0KK	1R0KK	---
0001---	0002---	0001---	2.0	3.54	5.00	6.12	2R0KK	2R0KK	2R0KK
0002---	0003---	0002---	2.5	3.16	4.47	5.50	2R5KK	2R5KK	2R5KK
0003---	0004---	0003---	3.0	2.89	4.08	5.00	3R0KK	3R0KK	3R0KK
---	0005---	0004---	4.0	---	3.54	4.34	---	4R0KK	4R0KK
0004---	0006---	0005---	5.0	2.24	3.16	3.87	5R0KK	5R0KK	5R0KK
0005---	0007---	0006---	6.0	2.04	2.89	3.54	6R0KK	6R0KK	6R0KK
0006---	0008---	0007---	8.0	1.77	2.50	3.06	8R0KK	8R0KK	8R0KK
0007---	0009---	0008---	10	1.58	2.24	2.74	100KK	100KK	100KK
---	0010---	0009---	12	---	2.04	2.50	---	120KK	120KK
0008---	0011---	0010---	15	1.29	1.83	2.24	150KK	150KK	150KK
0009---	0012---	0011---	25	1.00	1.41	1.73	250KK	250KK	250KK
0010---	0013---	0012---	35	0.85	1.19	1.46	350KK	350KK	350KK
0011---	0014---	0013---	50	0.71	1.00	1.22	500KK	500KK	500KK
0012---	0015---	0014---	75	0.58	0.82	1.00	750KK	750KK	750KK
0013---	0016---	0015---	100	0.50	0.71	0.87	101KK	101KK	101KK
0014---	0017---	0016---	150	0.41	0.58	0.71	151KK	151KK	151KK
0015---	0018---	0017---	200	0.35	0.50	0.61	201KK	201KK	201KK
0016---	0019---	0018---	250	0.32	0.45	0.55	251KK	251KK	251KK
0017---	0020---	0019---	350	0.27	0.38	0.46	351KK	351KK	351KK
0018---	0021---	0020---	500	0.22	0.32	0.39	501KK	501KK	501KK
0019---	0022---	0021---	750	0.18	0.26	0.32	751KK	751KK	751KK
0020---	0023---	0022---	1,000	0.16	0.22	0.27	102KK	102KK	102KK
0021---	0024---	0023---	1,500	0.13	0.18	0.22	152KK	152KK	152KK
0022---	0025---	0024---	2,500	0.10	0.14	0.17	252KK	252KK	252KK
0023---	0026---	0025---	3,500	0.08	0.12	0.15	352KK	352KK	352KK
0024---	0027---	0026---	5,000	0.07	0.10	0.12	502KK	502KK	502KK
---	0028---	0027---	8,000	---	0.08	0.10	---	802KK	802KK
---	0029---	0028---	10,000	---	0.07	0.09	---	103KK	103KK

See footnote at end of table.

FIGURE 203-4. Wirewound, variable resistors (power type) - Continued.

STYLES RP25 AND RP30

Part number 1/		Nominal total resistance value (ohms)	Maximum current (amperes)		Type designation 1/	
Style RP25	Style RP30		Style RP25	Style RP30	Style RP25	Style RP30
M22/08-	M22/09-				RP25---	RP30---
0001---	0001---	2.0	7.07	8.66	2R0KK	2R0KK
0002---	0002---	2.5	6.32	7.75	2R5KK	2R5KK
0003---	0003---	3.0	5.77	7.07	3R0KK	3R0KK
0004---	0004---	4.0	5.00	6.12	4R0KK	4R0KK
0005---	0005---	5.0	4.47	5.48	5R0KK	5R0KK
0006---	0006---	6.0	4.08	5.00	6R0KK	6R0KK
0007---	0007---	8.0	3.53	4.33	8R0KK	8R0KK
0008---	0008---	10	3.16	3.87	100KK	100KK
0009---	0009---	12	2.89	3.54	120KK	120KK
0010---	0010---	15	2.58	3.16	150KK	150KK
0011---	0011---	25	2.00	2.45	250KK	250KK
0012---	0012---	35	1.69	2.07	350KK	350KK
0013---	0013---	50	1.41	1.73	500KK	500KK
0014---	0014---	75	1.15	1.41	750KK	750KK
0015---	0015---	100	1.00	1.22	101KK	101KK
0016---	0016---	150	0.82	1.00	151KK	151KK
0017---	0017---	200	0.71	0.87	201KK	201KK
0018---	0018---	250	0.63	0.77	251KK	251KK
0019---	0019---	350	0.54	0.66	351KK	351KK
0020---	0020---	500	0.45	0.55	501KK	501KK
0021---	0021---	750	0.37	0.45	751KK	751KK
0022---	0022---	1,000	0.32	0.39	102KK	102KK
0023---	0023---	1,500	0.26	0.32	152KK	152KK
0024---	0024---	2,500	0.20	0.25	252KK	252KK
0025---	0025---	3,500	0.17	0.21	352KK	352KK
0026---	0026---	5,000	0.14	0.17	502KK	502KK
0027---	0027---	8,000	0.11	0.14	802KK	802KK
0028---	0028---	10,000	0.10	0.12	103KK	103KK

1/ The complete part number (and type designation) includes symbols indicating electrical off position, style of shaft and type of mounting, and length of operating shaft (see figure 203-2 for part number and 203-3 for type designation).

FIGURE 203-4. Wirewound, variable resistors (power type) - Continued.

TABLE 203-I. Performance characteristics.

Features	Style						
	RP05	RP05	RP10	RP15	RP20	RP25	RP30
Max ambient temp at rated wattage	25°C	25°C	25°C	25°C	25°C	25°C	25°C
Max ambient temp at zero wattage	340°C	340°C	340°C	340°C	340°C	340°C	390°C
Power rating (watts)	5.0	12.5	25	50	75	100	150
Torque (operating)	0.25 inch-ounce min 3.0 inch-ounces max	0.5 inch-ounce min 6.0 inch-ounces max	4 inch-ounces min 2.5 inch-pounds max	4 inch-ounces min 2.5 inch-pounds max	4 inch-ounces min 3 inch-pounds max	4 inch-ounces min 3 inch-pounds max	4 inch-ounces min 3 inch-pounds max
Electrical off position	1	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3
Total mechanical rotation	300 ±5°	300°, +5° -10°	290°, ±15°	300°, +10° -5°	300°, +10° -5°	300°, +15° -5°	305°, +10° -15°
Dielectric withstanding voltage:							
Atmospheric (volts rms)	500	500	1,000	1,000	1,000	1,000	1,000
Reduced (volts)	250	250	550	550	550	550	550
Min total resistance (ohms)	10	1.0	2.0	1.0	2.0	2.0	2.0
Max total resistance (ohms)	5,000	3,500	5,000	10,000	10,000	10,000	10,000
Low temperature exposure (-55°C)	Torque ≤8 inch-ounces	Torque ≤8 inch-ounces	Torque ≤4 inch-pounds	Torque ≤4 inch-pounds	Torque ≤4 inch-pounds	Torque ≤4 inch-pounds	Torque ≤4 inch-pounds
Max percent change in resistance:							
Life (1,000 hr) at 25°C full load	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Humidity (stead state) (96 hour)	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Acceleration	N/A	See 1/	---	---	---	---	---
Life (rotation):							
Standard bushing 5,000 cycles Locking bushing 500 cycles	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Shock	2.0	2.0	2.0	2.0	2.0	2.0	---
Vibration:							
(high frequency)	2.0	2.0	---	---	---	---	---
(low frequency)	---	---	5.0	5.0	5.0	5.0	5.0
Salt spray (48 hour)	No corrosion	No corrosion	No corrosion	No corrosion	No corrosion	No corrosion	No corrosion

1/ 10.0/contact arm, 3.0 total.

SECTION 204

RESISTORS, VARIABLE, WIREWOUND, PRECISION

STYLES RR0900, RR1000, RR1100, RR1300, RR1400, RR2000, RR2100, RR3000, RR3100, RR3200, RR3300, RR3400, RR3500, RR3700, RR3900, RR4000, AND RR4100

(APPLICABLE SPECIFICATION: MIL-R-12934)

1. SCOPE. This section covers precision, wirewound, variable resistors whose electrical output (in terms of percent of applied voltage) is linear with respect to the angular position of the operating shaft. These resistors are capable of full-load operation at maximum ambient temperature of 85°C and are suitable for continuous operation, when properly derated, at a maximum temperature of 150°C. These resistors are available with initial resistance tolerances of ±1 and ±3 percent.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have a resistance element consisting of a continuous length of resistance wire wound with precision on an arc or helix of insulating material. The moving contact is insulated from the operating shaft and maintains continuous electrical travel throughout the entire mechanical travel. The element and contact arm are enclosed in an environmentally resistant housing.

2.1.2 Selection of a safe resistor style. The wattage rating of these resistors is based on operation at 85°C, mounted on a 4-inch square, .250-inch thick alloy aluminum panel. This mounting technique should be taken into consideration when a wattage is dissipated during specific applications.

2.1.3 Derating at high temperature. These resistors may be used at the full nominal wattage at an ambient temperature of 85°C. When a resistor is to be used where the surrounding temperature is higher than 85°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the derating curve shown on figure 204-1.

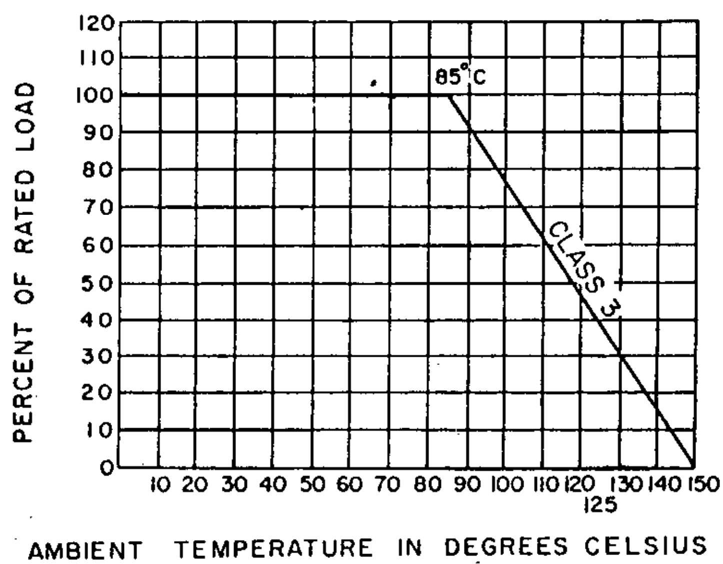


FIGURE 204-1. Derating curves for high ambient temperatures.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor having an adequate wattage rating.

2.1.5 Resistance-temperature characteristic. Consideration should be given to the temperature rise and ambient temperature of resistors under operation, in order to allow for the change in resistance due to resistance-temperature characteristic.

2.1.6 Definitions. Definitions of the special characteristics and parameters of these potentiometers are contained in MIL-R-12934.

3. ITEM IDENTIFICATION (see figures 204-2 and 204-3).

3.1 Type designation. The type designation is used for describing the resistor as shown on figure 204-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in tables 204-I and 204-II.

3.3 Preferred values. The preferred nominal resistance values are as follows:

Nominal total resistance value	
100 ohms	40,000 ohms
200 ohms	50,000 ohms
500 ohms	60,000 ohms
1,000 ohms	.100 megohm
2,000 ohms	.150 megohm
5,000 ohms	.200 megohm
10,000 ohms	.250 megohm
20,000 ohms	

The maximum value applicable to each style shall be as listed in tables 204-I and 204-II.

RR0900 B 3 A 9 G 101

STYLE: The the two-letter symbol "RR" identifies precision, wirewound, variable resistors; and the four-digit number identifies the physical size.

FUNCTION AND SHAFT LENGTH: The single-letter symbol identifies the type of function (linear) and shaft length (in inches ±1/32 inch) as follows:

A - - - - 3/8 (servo mounted):
3/4 (bushing mounted, single turn)
B - - - - 1/2 (servo mounted):
7/8 (bushing mounted, single turn)
C - - - - 5/8 (servo mounted):
1 (bushing mounted, single turn;
5/8 multi-turn)
D - - - - 3/4 (servo mounted):
1-1/8 (bushing mounted, single turn;
3/4 multi-turn)
E - - - - 7/8 (servo mounted):
1-1/4 (bushing mounted, single turn;
7/8 multi-turn)
F - - - - 1 (servo mounted):
1-3/8 (bushing mounted, single turn;
1 multi-turn)

CLASS AND CENTER TAP: The single-digit number identifies the class (85°C maximum ambient temperature at rated wattage, 150°C maximum ambient operating temperature); and center tap as follows:

3 - - - - - Not applicable
5 - - - - - Applicable

RESISTANCE-TEMPERATURE CHARACTERISTIC: The single-letter symbol identifies the resistance-temperature characteristic (in percent per °C) as follows:

A - - - - - ±.003
C - - - - - ±.010

ROTATIONAL LIFE CHARACTERISTIC: The single-digit number identifies the rotational-life characteristic (in cycles) as follows:

9 - - - - - 500,000 single turn; 100,000 ten turn

FUNCTION CONFORMITY TOLERANCE (FCT) AND RESISTANCE TOLERANCE (RT) CHARACTERISTIC: The single-letter symbol identifies the FCT and RT as follows:

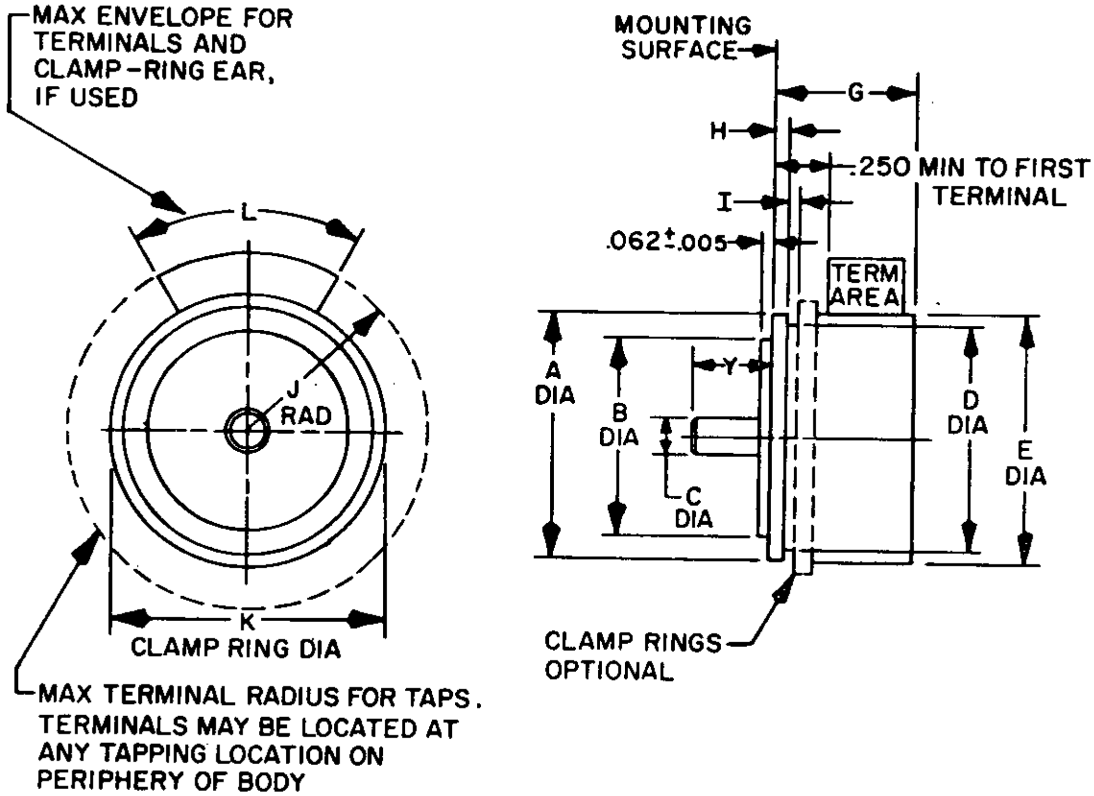
G - - - - - ±1.0 percent FCT; ±3 percent RT
J - - - - - ±0.10 percent FCT; ±3 percent RT
L - - - - - ±0.025 percent FCT; ±3 percent RT
S - - - - - ±1.0 percent FCT; ±1 percent RT
V - - - - - ±0.10 percent FCT; ±1 percent RT
Y - - - - - ±0.025 percent FCT; ±1 percent RT

RESISTANCE: The three-digit number identifies the nominal total resistance value, expressed in ohms. The first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE: 101 100 ohms
103 10,000 ohms

FIGURE 204-2. Type designation example.

STYLES RR0900, RR1000, RR1100, RR1300, RR1400, RR2000, RR2100, AND RR3000

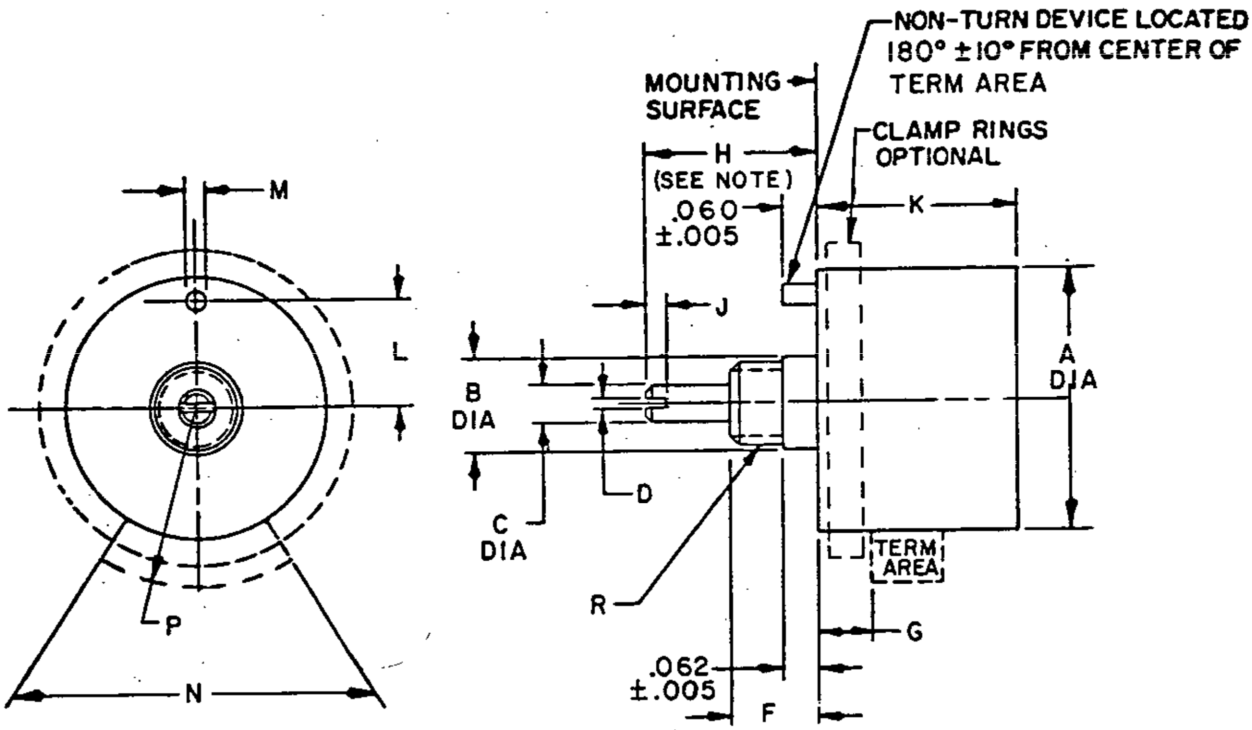


Style	Dimensions									
	A +.005(.13) -.010(.25)	B -.0005 (.01)	C -.0005 (.01)	D Max	E Max	G Max	H ±.005 (.13)	I Min	J Max	K Max	L Max
RR0900	.875 (22.23)	.7500 (19.05)	.1250 (3.18)	.781 (19.84)	.906 (23.01)	.812 (20.62)	.062 (1.57)	.057 (1.45)	.656 (16.66)	1.062 (26.97)	105°
RR1100	1.062 (26.97)	.9688 (24.61)	.1250 (3.18)	.975 (24.77)	1.125 (28.58)	.812 (20.62)	.062 (1.57)	.057 (1.45)	.781 (19.84)	1.160 (29.46)	100°
RR2000	2.000 (50.80)	1.8750 (47.63)	.2500 (6.35)	1.875 (47.63)	2.031 (51.59)	1.312 (33.32)	.093 (2.36)	.073 (1.85)	1.375 (34.93)	2.250 (57.15)	90°
RR3000	3.000 (76.20)	2.8750 (73.03)	.2500 (6.35)	2.875 (73.03)	3.031 (76.99)	1.312 (33.32)	.093 (2.36)	.073 (1.85)	1.750 (44.45)	3.250 (82.55)	90°
RR1000	.875 (22.23)	.7500 (19.05)	.1250 (3.18)	.781 (19.84)	.906 (23.01)	1.625 (41.28)	.062 (1.57)	.057 (1.45)	.656 (16.66)	1.062 (26.97)	105°
RR1300	1.437 (36.50)	1.3125 (33.32)	.2500 (6.35)	1.313 (33.35)	1.468 (37.28)	1.062 (26.97)	.093 (2.36)	.073 (1.85)	1.094 (27.79)	1.625 (41.28)	100°
RR1400	1.437 (36.50)	1.3125 (33.32)	.2500 (6.35)	1.313 (33.35)	1.468 (37.28)	2.250 (57.15)	.093 (2.36)	.073 (1.85)	1.094 (27.79)	1.625 (41.28)	100°
RR2100	2.000 (50.80)	1.8750 (47.63)	.2500 (6.35)	1.875 (47.63)	2.031 (51.59)	2.250 (57.15)	.093 (2.36)	.073 (1.85)	1.375 (34.93)	2.250 (57.15)	100°

NOTE: For dimension Y, see shaft length on figure 204-2.

FIGURE 204-3. Wirewound, precision variable resistors.

STYLES RR3100, RR3200, RR3300, RR3400, RR3500, RR3700, RR3900, RR4000, AND RR4100



BUSHING MOUNT

Style	Dimensions												
	A max	B ±.010 (.25)	C ±.005 (.13)	D ±.010 (.25)	F ±.020 (.51)	G min	J ±.010 (.25)	K max	L ±.005 (.13)	M ±.005 (.13)	N max	P max	R Threads (UNEF-2A)
RR3100	.906 (23.01)	.281 (7.14)	.125 (3.18)	.040 (1.02)	.250 (6.35)	.080 (2.03)	.040 (1.02)	.750 (19.05)	.312 (7.92)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR3200	1.093 (27.76)	.281 (7.14)	.125 (3.18)		.250 (6.35)	.100 (2.54)	.040 (1.02)	.750 (19.05)	.312 (7.92)	.062 (1.57)	105°	.781 (19.84)	.250-32
RR3300	1.468 (37.29)	.406 (10.31)	.250 (6.35)		.375 (9.52)		.060 (1.52)	1.062 (26.97)	.531 (13.49)	.125 (3.18)	100°	1.094 (27.79)	.375-32
RR3400	2.031 (51.59)	.406 (10.31)	.250 (6.35)		.375 (9.52)		.060 (1.52)	1.156 (29.36)	.750 (19.05)	.125 (3.18)	90°	1.375 (34.93)	.375-32
RR3500	3.031 (76.99)	.406 (10.31)	.250 (6.35)	.050 (1.27)	.375 (9.52)		.060 (1.52)	1.156 (29.36)	1.000 (25.40)	.125 (3.18)	90°	1.750 (44.45)	.375-32
RR3700	.906 (23.01)	.281 (7.14)	.125 (3.18)	.040 (1.02)	.250 (6.35)	.080 (2.03)	.040 (1.02)	1.076 (27.33)	.312 (7.92)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR3900	.906 (23.01)	.281 (7.14)	.125 (3.18)		.250 (6.35)			1.219 (30.96)	.312 (7.92)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR4000	.875 (22.22)	.281 (7.14)	.125 (3.18)		.313 (7.95)			1.500 (38.10)	.302 (7.66)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR4100	1.844 (46.84)	.406 (10.31)	.250 (6.35) ±.002 (.05)		.313 (7.95)			2.094 (53.19)	.562 (14.27)	.125 (3.18)	100°	1.375 (34.93)	.375-32

NOTE: For dimension H, see shaft length on figure 204-2.

FIGURE 204-3. Wirewound, precision variable resistors - Continued.

TABLE 204-I. Performance characteristics.

Features	Style RR0900	RR1100	RR2000	RR3000	RR1000	RR1300	RR1400	RR2100
Shaft Diameter	.125	.125	.250	.250	.125	.250	.250	.250
Cup Diameter	7/8	1-1/16	2	3	7/8	1-7/16	1-7/16	2
Resistance range Maximum Minimum	10 kΩ 100 kΩ	20 kΩ 100 kΩ	50 kΩ 100 kΩ	100 kΩ 200 kΩ	50 kΩ 100 kΩ	40 kΩ 100 kΩ	200 kΩ 200 kΩ	250 kΩ 200 kΩ
Power rating, watts at 85°C 150°C	1.25 0	1.5 0	4 0	6 0	2 0	2 0	3 0	5 0
Maximum continuous working voltage	250	250	250	250	500	250	500	500
Rotational life (1,000 cycles)	500	500	500	500	100	500	100	100
Operating RPM	100 RPM							
Maximum starting and running torque in inch-ounces, single turn, single cup Starting Running	.30 .25	.50 .30	1.0 1.0	1.5 1.0	.7 .6	1.0 .75	1.0 .7	2.0 1.0
Travel (degrees) Electrical Mechanical	350 360	350 360	350 360	350 360	3,600 3,600	350 360	3,600 3,600	3,600 3,600
Stops Torque (inch-pound)					3		8	37.5
Weight Basic (ounces max)	1	1.25	4	8	1.5	1.5	5	8
Insulation resistance	100 megohms initial; 100 megohms degradation							
Dielectric withstanding voltage	No damage, arcing, etc; 1 mA leakage current							
Peak noise	100 ohms min; 500 ohms max degradation							
Terminal strength	No mechanical damage							
Temperature cycling	±5 percent ΔR							
Rotational load life	±5 percent ΔR							
Low temperature operation	±5 percent ΔR							
Low temperature exposure	±5 percent ΔR							
High temperature exposure	±5 percent ΔR							
Shock	No mechanical or electrical damage or momentary discontinuity							
Vibration, high frequency	±5 percent ΔR							
Salt spray (corrosion)	No appreciable corrosion							
Moisture resistance	±3 percent ΔR; insulation resistance not less than 10 megohms							

TABLE 204-II. Performance characteristics.

Features	Style RR3100	RR3200	RR3300	RR3400	RR3500	RR3700	RR3900	RR4000	RR4100
Shaft Diameter	.125	.125	.250	.250	.250	.125	.125	.125	.250
Resistance range Maximum Minimum	10 kΩ 100 kΩ	20 kΩ 100 kΩ	40 kΩ 100 kΩ	60 kΩ 100 kΩ	100 kΩ 200 kΩ	50 kΩ 100 kΩ	100 kΩ 100 kΩ	50 kΩ 100 kΩ	250 kΩ 200 kΩ
Power rating, watts at 85°C 150°C	1.25 0	1.50 0	2 0	4 0	6 0	1.50 0	1.50 0	2 0	5 0
Maximum continuous working voltage	250	250	250	250	250	423	500	300	500
Rotational life (1,000 cycles)	500	500	500	500	500	350	200	100	100
Operating RPM	100 RPM								
Maximum starting and running torque in inch-ounces, single turn, single cup Starting Running	.30 .25	.50 .40	1.0 .75	1.0 1.0	1.5 1.0				
Travel (degrees) Electrical Mechanical	350 360	350 360	350 360	350 360	350 360	1,080 1,080	1,180 1,180	3,600 3,600	3,600 3,600
Stops Torque (inch-pound)						3	3	3	10
Weight Basic (ounces max)	1	1.25	1.60	4	8	0.8	1	1.44	8

Insulation resistance	100 megohms initial; 100 megohms degradation
Dielectric withstanding voltage	No damage, arcing, etc; 1 mA leakage current
Peak noise	100 ohms min; 500 ohms max degradation
Terminal strength	No mechanical damage
Temperature cycling	±5 percent ΔR
Rotational load life	±5 percent ΔR
Low temperature operation	±5 percent ΔR
Low temperature exposure	±5 percent ΔR
High temperature exposure	±5 percent ΔR
Shock	No mechanical or electrical damage or momentary discontinuity
Vibration, high frequency	±5 percent ΔR
Salt spray (corrosion)	No appreciable corrosion
Moisture resistance	±3 percent ΔR; insulation resistance not less than 10 megohms

SECTION 205

RESISTORS, VARIABLE, WIREWOUND, SEMI-PRECISION

STYLE RK09

(APPLICABLE SPECIFICATION: MIL-R-39002)

1. SCOPE. This section covers semi-precision, wirewound, variable resistors having a resistance element of wire, wound linearly on an insulated form shaped in an arc, so that a contact bears uniformly on the resistance element when adjusted by a contact shaft. The electrical output (in terms of percent of applied voltage) is linear with respect to the angular position of the contact arm. These resistors are capable of full-load operation (when the maximum resistance is engaged) at a maximum ambient temperature of 85°C and are suitable for continuous operation, when properly derated, at a maximum temperature of 135°C. These resistors have a tolerance of ±5 percent.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. The construction of these resistors conforms, in general, to that specified in sections 202 and 203. However, due to the nature of these components, manufacturing and measurement techniques are more precise. The element which is of a precisely determined, continuous length of wire, is afforded environmental protection by a housing or enclosure. The rotating contact is electrically insulated from the shaft, bushing, or housing.

2.1.2 Selection of a safe resistor style. The wattage rating of these resistors is based on operation at 85°C, mounted on a 4-inch square, .050-inch thick, steel panel. This mounting technique should be taken into consideration when the wattage is applied during specific applications.

2.1.3 Derating at high temperature. These resistors may be used at the full nominal wattage at an ambient temperature of 85°C. When a resistor is to be used where the surrounding temperature is higher than 85°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the derating curve shown on figure 205-1.

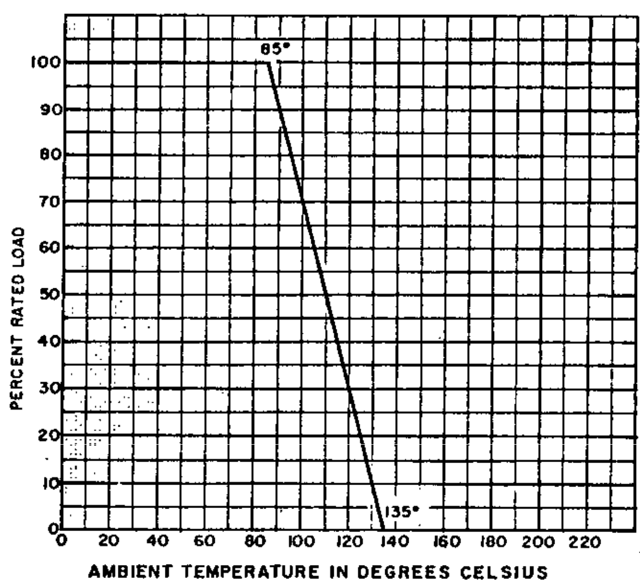


FIGURE 205-1. Derating curve for high ambient temperature.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor having an adequate wattage rating.

2.2 Resistance-temperature characteristic. Consideration should be given to temperature rise and ambient temperature of resistors under operation, in order to allow for the change in resistance due to resistance-temperature characteristic. Resistance tolerance may easily be exceeded unless care is exercised.

2.3 Supplementary insulation. Where voltages higher than 250 volts rms are present between the resistor circuit and grounded surface on which the resistor is mounted, or where the dc resistance is so high that the insulation resistance to ground is an important factor, secondary insulation to withstand the conditions should be provided between the resistor and mounting or between the mounting and ground.

2.4 Reduction of power rating. When only a portion of the resistance element is engaged, the wattage rating is reduced in approximately the same proportion as the resistance.

3. ITEM IDENTIFICATION (see figures 205-2 through 205-4).

3.1 Part number. The part number is used for identifying the resistor as shown on figure 205-2.

M39002/01- 0001

SPECIFICATION NUMBER: The number identifies the detail specification number (indicating MIL-R-39002/1).

DASH NUMBER: The applicable dash number is as indicated in figure 205-4 and corresponds to the type designation per figure 205-3.

FIGURE 205-2. Part number example.

3.2 Type designation. The type designation is used for describing the resistor as shown on figure 205-3.

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in table 205-I.

3.4 Resistance values. The nominal total resistance values are as follows:

Ohms	Ohms	Ohms
10	100	1,000
15	150	1,500
20	200	2,000
25	250	2,500
35	350	3,500
50	500	5,000
75	750	7,500
		10,000

RK09 SA C S 101

STYLE: The two-letter symbol "RK" identifies semi-precision, wirewound, variable resistors; the two-digit number identifies the physical size of the resistor.

SHAFT AND TYPE MOUNTING: The two-letter symbol identifies shaft style, type of mounting, and shaft length. The first letter "S" indicates a slotted shaft style and standard bushing mounting; and the "U" indicates a slotted shaft style and locking bushing mounting. The second letter indicates the shaft length (±.031 inch) as follows:

A - - - - .500 inch
B*- - - - .625 inch

*Available in standard bushing only.

RESISTANCE-TEMPERATURE CHARACTERISTIC: The single-letter symbol "C" identifies the maximum resistance-temperature characteristic (ref to 25°C) as follows:

±200 ppm (under 50 ohms)
±70 ppm (50 ohms and over)

TERMINALS: The single-letter symbol "S" identifies solder-lug type terminals.

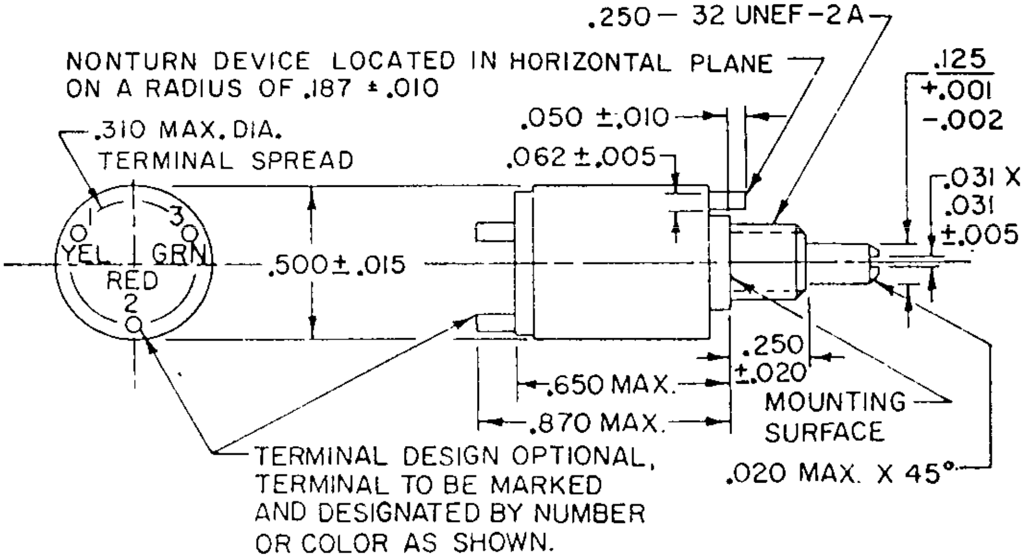
RESISTANCE: The three-digit number identifies the nominal total resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.4 and the following example.)

EXAMPLE:

100 - - - - 10 ohms
101 - - - - 100 ohms
102 - - - - 1,000 ohms

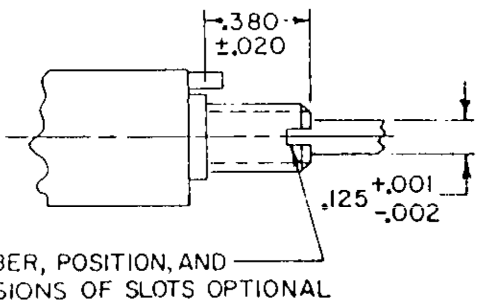
FIGURE 205-3. Type designation example.

STYLE RK09



STANDARD-BUSHING TYPE

Inches	mm	Inches	mm
.001	0.03	.125	3.18
.002	0.05	.187	4.75
.005	0.13	.250	6.35
.010	0.25	.310	7.87
.015	0.38	.380	9.65
.020	0.51	.500	12.70
.031	0.79	.650	16.51
.050	1.27	.870	22.10
.062	1.57		



LOCKING-BUSHING TYPE

NOTE: This style resistor is supplied with one mounting nut .062 inch (1.57 mm) thick which measures .312 inch (7.92 mm) across the hexagonal flats. For locking bushings, the locking nut is .125 inch (3.18 mm) thick and measures .312 inch (7.92 mm) across the hexagonal flats. Thread size is .250-32 UNEF-2B. An internal-tooth lockwasher is supplied and, when mounted, has a maximum thickness of approximately .045 inch (1.14 mm). Retainer rings, if used, are not thicker than .032 inch (0.81 mm).

FIGURE 205-4. Wirewound, semi-precision, variable resistors.

Nominal total resistance (ohms)	Part no. M39002/01- .500 inch slotted shaft		.625 inch slotted shaft		Type designation 1/
	Locking bushing	Standard bushing	Locking bushing	Standard bushing	
10	0001	0028	---	0055	RK09--CS100
15	0002	0029	---	0056	RK09--CS150
20	0003	0030	---	0057	RK09--CS200
25	0004	0031	---	0058	RK09--CS250
35	0005	0032	---	0059	RK09--CS350
50	0006	0033	---	0060	RK09--CS500
75	0007	0034	---	0061	RK09--CS750
100	0008	0035	---	0062	RK09--CS101
150	0009	0036	---	0063	RK09--CS151
200	0010	0037	---	0064	RK09--CS201
250	0011	0038	---	0065	RK09--CS251
350	0012	0039	---	0066	RK09--CS351
500	0013	0040	---	0067	RK09--CS501
750	0014	0041	---	0068	RK09--CS751
1,000	0015	0042	---	0069	RK09--CS102
1,500	0016	0043	---	0070	RK09--CS152
2,000	0017	0044	---	0071	RK09--CS202
2,500	0018	0045	---	0072	RK09--CS252
3,500	0019	0046	---	0073	RK09--CS352
5,000	0020	0047	---	0074	RK09--CS502
7,500	0021	0048	---	0075	RK09--CS752
10,000	0022	0049	---	0076	RK09--CS103

1/ Complete type designation includes additional symbols indicating type of mounting and shaft length (where applicable).

FIGURE 205-4. Wirewound, semi-precision, variable resistors - Continued.

TABLE 205-I. Performance requirements.

Features	Style RK09
Max resistance-temperature characteristic in ppm/°C (Ref to 25°C) — 50 ohms and over	±70
Max resistance-temperature characteristic in ppm/°C (Ref to 25°C) — Under 50 ohms	±200
Min nominal total resistance (ohms)	10
Max nominal total resistance (ohms)	10 kΩ
Max ambient temperature at rated wattage	85°C
Max ambient temperature at zero wattage derating	135°C
Power rating (watts)	1.5
Mechanical travel (degrees)	325 ±10
Actual effective-electrical travel (degrees)	320 ±10
Max noise (degradation)	500 Ω
Max independent linearity (initial)	3 percent
Max independent linearity (degradation)	150 percent
Min insulation resistance (megohms):	
Dry	1,000
Wet (after moisture resistance)	100
Torque (starting) (ounces)	0.5 to 6.0
Salt spray	No evidence of corrosion (mechanically operative)
Max percent change in resistance 1/:	
Moisture resistance	3.0
Acceleration	1.0
Thermal shock	1.0
Shock (specified pulse)	1.0
Vibration, high frequency	1.0
Resistance to soldering heat	1.0
Life	2.0
Low-temperature operation	1.0
High-temperature exposure	3.0
Rotational life	3.0

1/ Where total resistance change is 1 percent, it shall be considered as ±(1 percent +0.05 ohm).

SECTION 206

RESISTORS, VARIABLE, WIREWOUND (ADJUSTMENT TYPE)

STYLE RT26

(APPLICABLE SPECIFICATION: MIL-R-27208)

1. SCOPE. This section covers lead-screw actuated, wirewound, variable resistors with a contact bearing uniformly over the surface of the entire resistive element, wound linearly, when positioned by a multiturn lead-screw actuator. These resistors are capable of full-load operation (when the maximum resistance is engaged) at a maximum ambient temperature of 85°C and are suitable for continuous operation, when properly derated, at a maximum temperature of 150°C. These resistors have a resistance tolerance of ±5 percent.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have an element of continuous-length wire, wound linearly on an arc-shaped core. The sliding contact traverses the element in a circular path. The element is protected from detrimental environmental conditions by a housing or enclosure. The lead-screw head is insulated from the electrical portion of the resistor.

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 85°C when mounted on a 1/16-inch thick, glass-base, epoxy laminate. Therefore, the heat-sink effect as provided by steel test plates in other specifications is not present. The wattage rating is applicable when the entire resistance element is engaged in the circuit. When only a portion is engaged, the wattage is reduced directly in the same proportion as the resistance.

2.1.3 Power rating. These resistors may be used at the full nominal wattage at an ambient temperature of 85°C. When a resistor is to be used where the surrounding temperature is higher than 85°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the derating curve shown on figure 206-1.

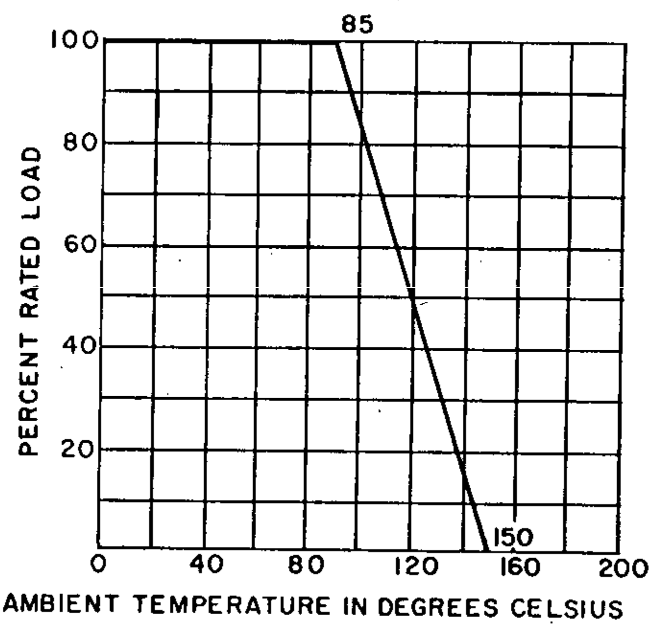


FIGURE 206-1. Derating curve for high-ambient temperature.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended.

2.1.5 High resistances and voltages. Where voltages higher than 250 volts rms are present between the resistor circuit and grounded surface on which the resistor is mounted, or where the dc resistance is so high that the insulation resistance to ground is an important factor, secondary insulation to withstand the conditions should be provided between the resistor and mounting or between the mounting and ground.

2.2 Mounting of resistors. Mounting hardware should be used. Printed-circuit types are frequently terminal mounted, although brackets may be necessary for a high-shock and vibration environment.

2.3 Stacking of resistors. When stacking resistors, care should be taken to compensate for the added rise in temperature by derating the wattage rating accordingly.

2.4 Resistance-temperature characteristic. Consideration should be given to temperature rise and ambient temperature of resistors under operation, in order to allow for the change in resistance due to resistance-temperature characteristic. The resistance-temperature characteristic is measured between the two end terminals. Whenever resistance-temperature characteristic is critical, variation due to the resistance of the movable contact should be considered.

2.5 Noise. The noise level is low compared to non-wirewound types. Peak noise is specification controlled at initial value of 100 ohms maximum. However, after exposure to environmental tests (moisture, shock, vibration, etc.), a degradation to 500 ohms is allowed by specification.

2.6 Maximum weight. Maximum weight is 0.6 gram.

3. ITEM IDENTIFICATION (see figures 206-2 and 206-3).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 206-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 206-I.

3.3 Preferred nominal resistance value, maximum resolution, and rated working voltage. The preferred nominal resistance value, maximum resolution, and rated working voltage are as follows:

Nominal resistance value	Maximum resolution	Rated ac and dc working voltage
Ohms	Percent	Volts
10	1.85	1.41
20	1.50	2.00
50	1.39	3.16
100	1.05	4.47
200	0.86	6.33
500	0.65	10.00
1,000	0.57	14.10
2,000 1/	0.44	20.00

1/ Value based on the use of wire having no less than 0.001-inch nominal diameter.

RT26 C 2 W 102

STYLE: The two-letter symbol "RT" identifies lead-screw actuated, wirewound, variable resistors; the two-digit number identifies the physical size.

RESISTANCE-TEMPERATURE CHARACTERISTIC: The single-letter symbol identifies the resistance-temperature characteristic as follows:

C - - - - - - 50 ppm/°C (ref to 25°C)

TEMPERATURE CHARACTERISTIC: The single-digit number "2" identifies the temperature characteristic as follows:

85°C max ambient temperature at rated wattage
150°C max ambient operating temp

TERMINALS: The single-letter symbol identifies the terminals as follows:

P - - - - - - Printed circuit pins
W - - - - - - Printed-circuit pins (edge-mounted)
X - - - - - - Printed-circuit pins (edge-mounted, alternate configuration)

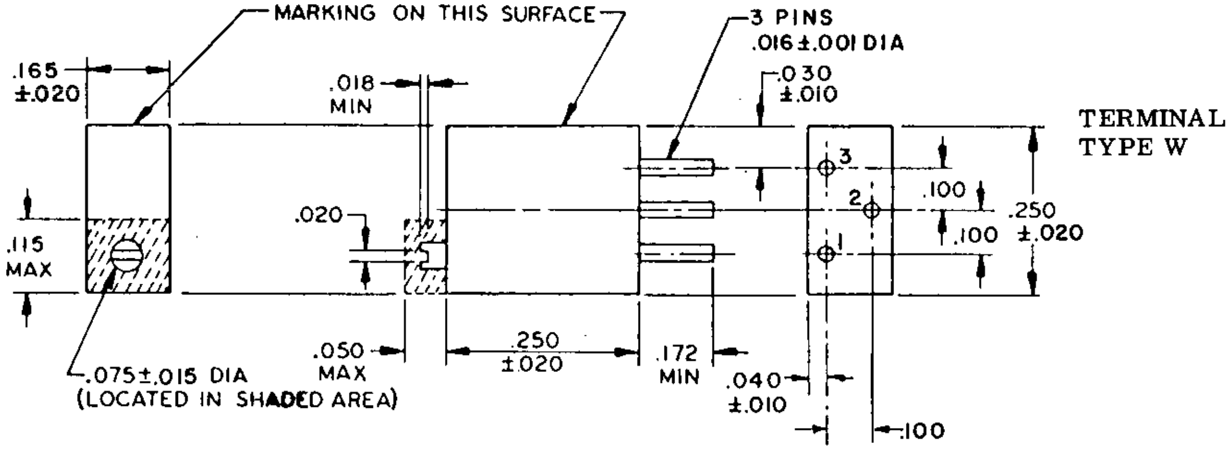
RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

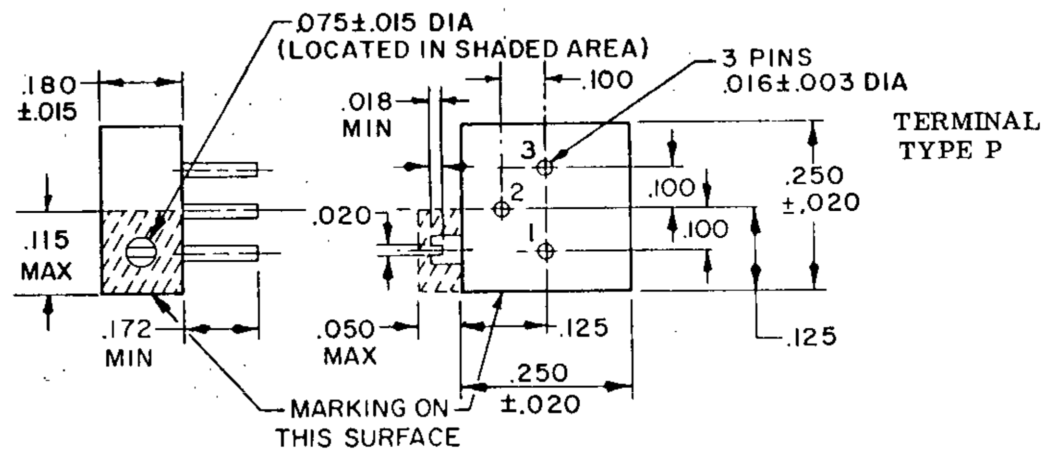
EXAMPLE:

100- - - - - 10 ohms
101- - - - - 100 ohms
102- - - - - 1,000 ohms

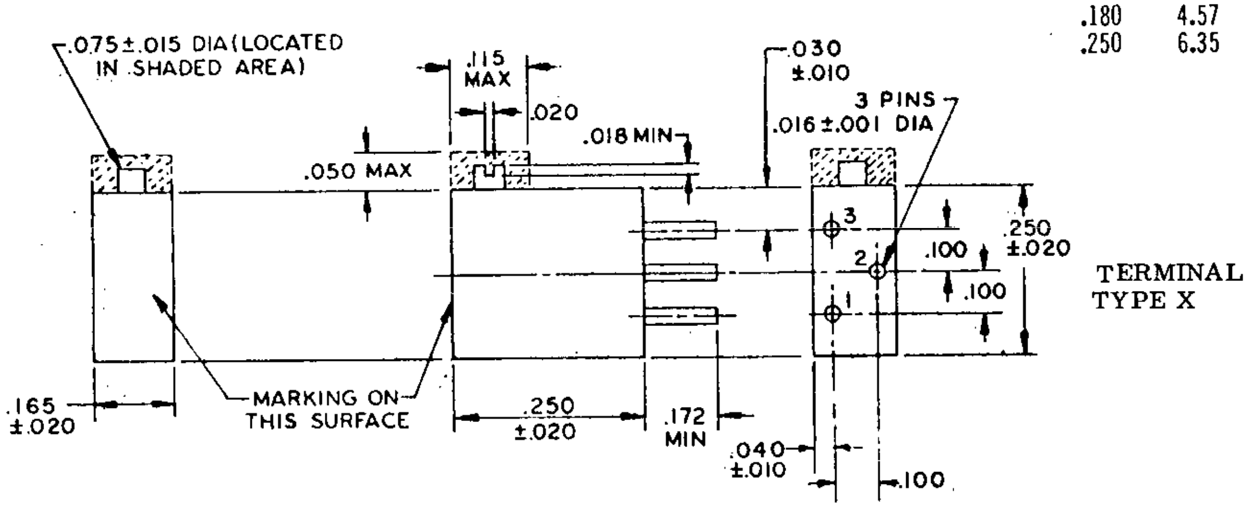
FIGURE 206-2. Type designation example.

4. DELETED STYLES. Resistors, styles RT12, RT22, and RT50, formerly covered in this section, have been intentionally deleted and are no longer standard items for new design. For new design, use styles RTR12 and RTR22 of MIL-R-39015 (see section 401).





Inches	mm
.001	.03
.003	.08
.010	.25
.015	.38
.016	.41
.018	.46
.020	.51
.030	.76
.040	1.02
.050	1.27
.075	1.91
.100	2.54
.115	2.92
.125	3.18
.165	4.19
.172	4.37
.180	4.57
.250	6.35



NOTES:
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The entire slot of the actuating screw is above the surface of the unit.

FIGURE 206-3. Wirewound, variable resistors (adjustment type, lead-screw actuated).

TABLE 206-I. Performance characteristics.

Features	Style RT26
Min nominal resistance value (ohms)	10
Max nominal resistance value (ohms)	2 kΩ
Max resistance-temperature characteristic (ppm/°C) (Ref to 25°C)	±50
Max ambient temperature at rated wattage	85°C
Max ambient temperature at zero wattage derating	150°C
Power rating (watts)	1/4
Setting stability	1 percent + maximum resolution after environmental tests
Max percent change in resistance:1/	
Thermal shock	1
Moisture resistance	1
Acceleration	1
Shock (specified pulse)	1
Vibration, high frequency	1
Resistance to soldering heat	1
Low-temperature operation	1
High-temperature exposure	1
Rotational life	2
Life	2
Resistance tolerance (± percent)	5
Peak noise	500 ohms max after environmental tests
Insulation resistance (megohms):	
Dry	1,000
Wet (after moisture resistance)	10
Dielectric withstanding voltage (volts rms)	
Atmospheric pressure, sea level	600
Reduced barometric pressure, 70,000 ft	250
Immersion	No continuous bubbles
Operating torque	3 inch-ounces max
Actual effective-electrical travel	10 turns min 25 turns max

1/ Where total resistance change is 1 percent, it shall be considered as ± (1 percent +0.05 ohm).

NOTE: All leads are solderable in accordance with method 208 of MIL-STD-202.

* SECTION 207

RESISTORS, VARIABLE, NON-WIREWOUND (ADJUSTMENT TYPE)

STYLE RJ24

(APPLICABLE SPECIFICATION: MIL-R-22097)

1. SCOPE. This section covers multiturn adjustment type and single turn non-wire wound, variable resistors with a contact bearing uniformly over the surface of the entire resistive element, when positioned by an actuator. These resistors are capable of full-load operation (when the maximum resistance is engaged) at maximum ambient temperature of 85°C, and are suitable for continuous operation, when properly derated, at a maximum temperature of 150°C. These resistors have a resistance tolerance of ±10 percent.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have an element of metal, Cermet type or carbon film (depending upon characteristic) deposited upon a ceramic or glass base. Depending upon style, the element is rectangular or shaped in an arc and the sliding contact maintains continuous contact when traversing the element in a straight line or circular motion. The element is protected from detrimental environmental conditions by a housing or enclosure. The lead screw head is insulated from the electrical portion of the resistor.

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 85°C when mounted on a 1/16-inch thick, glass base epoxy laminate; therefore, the heat sink effect as provided by steel test plates in other specifications is not present. The wattage rating is applicable when the entire resistance element is engaged in the circuit. When only a portion of the element is engaged, the wattage is reduced directly in the same proportion as the resistance.

2.1.3 Derating at high temperatures. These resistors may be used at full wattage at the applicable operating temperature. When a resistor is to be used where the surrounding temperature is higher than the applicable operating temperature, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the derating curve shown on figure 207-1.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating, with optimum performance.

2.1.5 High resistances and voltages. Where voltages higher than 250 volts rms are present between the resistor circuit and grounded surface on which the resistor is mounted, or where the dc resistance is so high that the insulation resistance to ground is an important factor, secondary insulation to withstand the conditions should be provided between the resistor and mounting or between the mounting and ground.

2.2 Mounting of resistors. Resistors should not be mounted by their flexible-wire leads. Mounting hardware should be used. Printed-circuit types are frequently terminal mounted, although brackets may be necessary for a high-shock and vibration environment.

2.3 Stacking of resistors. When stacking resistors, care should be taken to compensate for the added rise in temperature by derating the wattage rating accordingly.

2.4 Resistance-temperature characteristic. Consideration should be given to temperature rise and ambient temperature of resistors under operation, in order to allow for the change in resistance due to resistance-temperature characteristic. This characteristic is measured between the two end terminals. Whenever the resistance-temperature characteristic is critical, variation due to the movable contact's resistance should be considered.

2.5 Noise. Peak noise is not specification controlled.

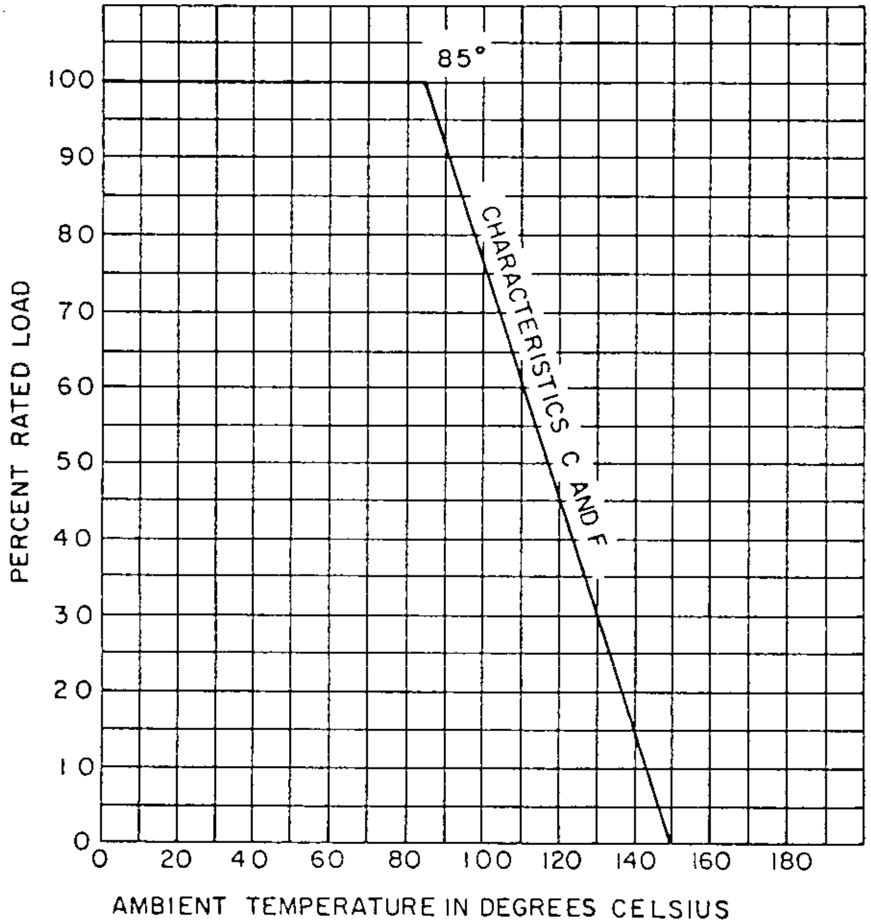


FIGURE 207-1. Derating curves for high ambient temperatures.

3. ITEM IDENTIFICATION (see figures 207-2 and 207-3).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 207-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 207-I.

* RJ24 C L 103

STYLE: The two-letter symbol "RJ" identifies adjustment types, non-wirewound, variable resistors; the two-digit number identifies the physical size.

CHARACTERISTIC: The single-letter symbol identifies the characteristic of the completed resistor as follows:

C - - - }
F - - - } See table 207-I.

TERMINALS: The single-letter symbol identifies the terminals as follows:

L - - - Flexible, insulated-wire leads

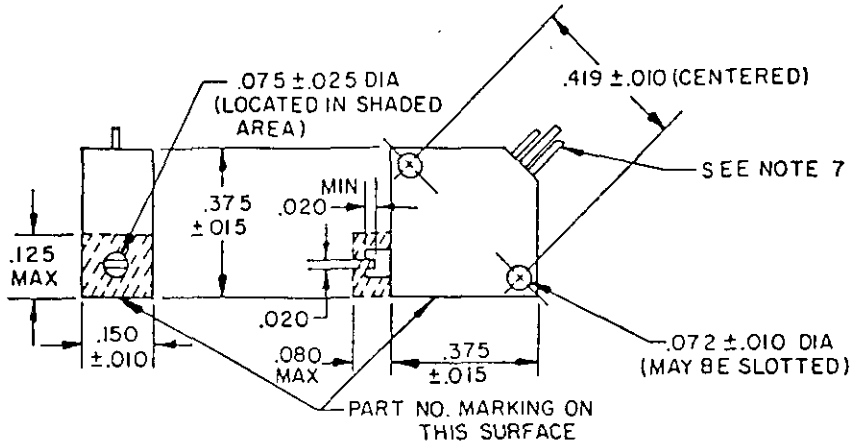
*

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:

101- - - - - 100 ohms
102- - - - - 1,000 ohms
103- - - - - 10,000 ohms

FIGURE 207-2. Type designation example.



TERMINAL TYPE L

NOTES:
1. The picturization of the styles above are given as representative of the envelope of the item. Slight deviations from the outline shown, which are contained within the envelope, and do not alter the functional aspects of the device are acceptable.
2. The entire slot of the actuating screw must be above the surface of the unit.
3. Unless otherwise specified, tolerance is ±.005 (0.13 mm).
4. Dimensions are in inches.
5. Metric equivalents are given for general information only.
6. The three leads shall be stranded wire, AWG size 28 to 30, having a minimum length of 6 (152.4 mm); they shall be insulated with polytetrafluoroethylene, stripped .250 ±.062 (6.35 ±1.57 mm) from the end, and color coded.

FIGURE 207-3. Style RJ24 resistor.

3.3 Preferred nominal resistance values and maximum rated working voltages. The preferred nominal resistance values and maximum rated working voltages are as follows:

*

Nominal resistance value	Rated working voltage RJ24
Ohms	Volts
10	2.23
20	3.1
50	5.0
100	7.0
200	10.0
500	15.8
1,000	22.3
2,000	31.6
5,000	50.0
10,000	70.7
20,000	100
25,000	111
50,000	158
Megohms	
0.10	223
0.25	300
0.50	300
1.00	300

* 4. DELETED STYLES. Resistors, styles RJ11, RJ12, RJ22, RJ24, (except terminal L) RJ26, and RJ50, formerly covered in this section have been intentionally deleted and are no longer standard items for new design. For new design, use RJR12, RJR24 (except terminal L), RJR26, RJR28, and RJR50 of MIL-R-39035 (see section 402).

* TABLE 207-I. Performance characteristics.

Features	Style RJ24 C	Style RJ24 F
Max resistance-temperature characteristic (Percent per °C)	±0.025	±0.010
(Parts per million/°C)	±250	±100
Max ambient temperature at rated wattage	85°C	85°C
Max ambient temperature at zero load derating	150°C	150°C
Power rating (watts)	1/2	1/2
Weight (grams, max)	1.3	1.3
Max percent change in resistance (±): 1/		
Contact-resistance variation 2/	3	3
Thermal shock	2	1
Moisture resistance	2	1
Shock (specified pulse)	1	1
Vibration, high frequency	1	1
Resistance to soldering heat (not applicable to terminal L)	1	1
Life	3	2
Low-temperature operation	2	1
High temperature exposure	3	2
Rotational life	2	2
Solderability (not applicable to terminal L)	Yes	Yes
Dielectric withstanding voltage	No arcing, breakdown, or leakage current <1 mA	Same as characteristic C
Atmospheric (volts)	900	900
Barometric (volts)	350	350
Insulation resistance (megohms):		
Dry	1,000	1,000
Wet (after moisture resistance)	100	100
Immersion (not applicable to terminal L)	No more than 3 bubbles	Same as characteristic C
Torque (operating) (stop is applicable to style RJ50 only)	5 inch-ounces max	5 inch-ounces max
Actual effective-electrical travel	15 turns min 30 turns max	15 turns min 30 turns max

1/ Where total resistance change is 1 percent, it shall be considered as ± (1 percent + 0.05 ohm).
2/ For characteristic C, contact resistance variation may be 3 percent or 20 ohms, whichever is greater.

SECTION 208

RESISTORS, VARIABLE, NON-WIREWOUND

STYLE RVC6

(APPLICABLE SPECIFICATION: MIL-R-23285)

1. SCOPE. This section covers non-wirewound, variable resistors. These resistors are suitable for rheostat or potentiometer applications where high precision is not required, and are capable of withstanding acceleration, shock, high-frequency vibration and 125°C operating temperature at rated load. They are most useful in circuitry where high resistance values and low power dissipation are encountered in controlling volume, bias, tone, voltage output, and pulse width.

2. APPLICATION INFORMATION.

2.1 Construction. These resistors have a film resistance element shaped in an arc, and a contact bearing uniformly thereon, so that a change of resistance is produced between the terminal of the contact and the terminal at either end of the resistance element when the operating shaft is turned. The construction of the element is metal-ceramic film fused onto a ceramic substitute. The element is then contained in an enclosure which provides for environmental and mechanical protection.

2.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 125°C, mounted on a 16-gauge steel plate, 4 inches square. This mounting technique should be taken into consideration when the wattage is applied during specific applications. When considering these resistors for potentiometer applications, it is necessary to bear in mind the fact that the load current as well as the "bleeder" current will be flowing through a part of the resistor and will contribute to the heating effect.

2.2.1 Derating at high temperature. When a resistor is to be used where the surrounding temperature is higher than 125°C, it should be derated in accordance with figure 208-1.

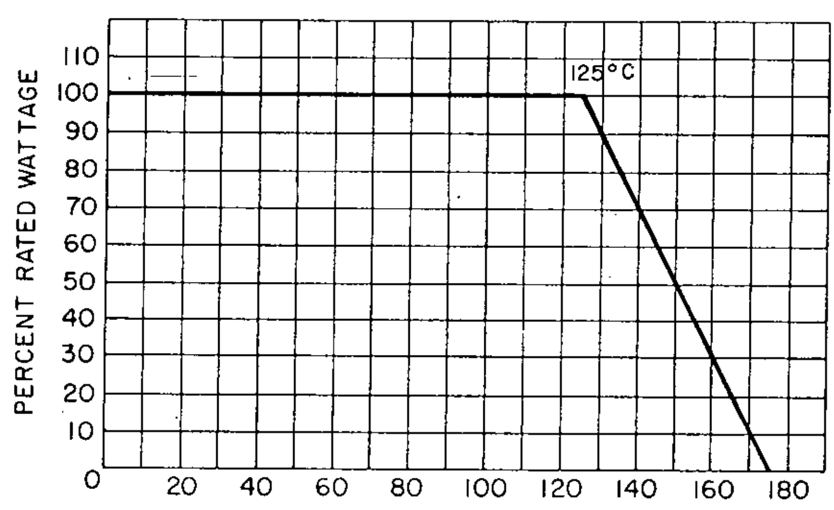


FIGURE 208-1. Derating curve.

2.2.2 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating with optimum performance.

2.3 Transient change in resistance. It is suggested that when these resistors encounter shock, acceleration, and high-frequency vibration forces of the magnitudes enumerated in this section, that they be used only in applications where a 6-percent variation can be tolerated in the resistance at the contact arm, when the shaft is unlocked.

2.4 Shaft-locking devices. Suitable locking devices are commercially available which may be readily attached to any standard-bushing type of resistor covered by this section. These locking devices permit any degree of torque from normal up to complete locking of the operating shaft of the resistor. The locking-bushing type of resistor specified herein provides the shaft-locking feature without additional equipment.

2.5 Maximum voltage. The maximum continuous working voltage specified for each of the styles should in no case be exceeded, regardless of the theoretical calculated rated voltage.

2.6 Supplementary insulation. These variable resistors should not be used at potentials to ground greater than 500 volts peak, or 200 volts peak for aircraft equipment, unless supplementary insulation is provided.

2.7 Noise. The noise level is quite low compared to composition variable resistors.

2.8 Linear and nonlinear tapers. Taper A is a linear resistance taper, which is one having a constant change of resistance with angular rotation, while taper C is a non-linear resistance taper, which has a variation or lack of constancy in the change of resistance with angular rotation. (See figure 208-2.)

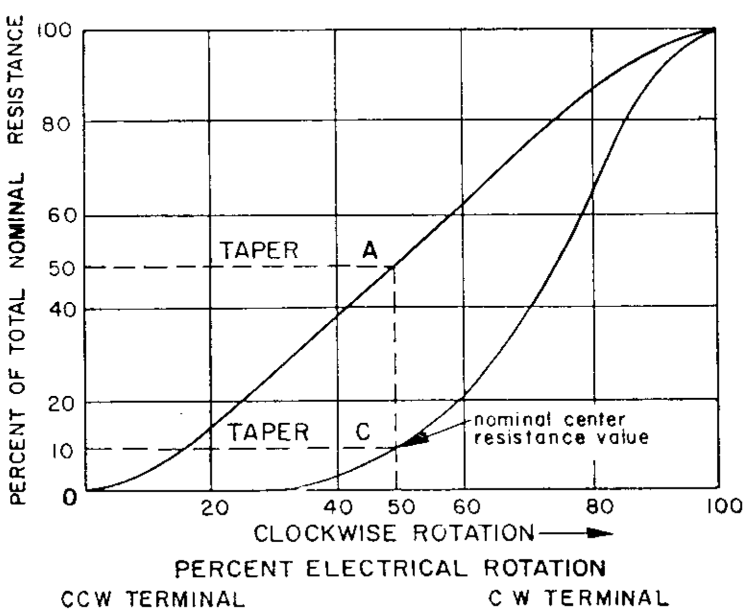


FIGURE 208-2. Clockwise taper.

3. ITEM IDENTIFICATION (see figures 208-3 and 208-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 208-3.

3.2 Performance characteristics. The performance characteristics of these resistors are shown in table 208-I.

3.3 Preferred resistance values and rated continuous working voltages. The preferred nominal total resistance values and rated continuous working voltages (RCWV) are as follows:

Nominal total resistance	RCWV (at 125°C)	
	Taper A	Taper C
100Ω	7 V	---
250Ω	11 V	---
500Ω	16 V	---
1,000Ω	22 V	16 V
2,500Ω	35 V	25 V
5,000Ω	50 V	36 V
10,000Ω	71 V	50 V
25,000Ω	112 V	80 V
50,000Ω	158 V	112 V
0.10 MΩ	224 V	160 V
0.25 MΩ	350 V	200 V
0.50 MΩ	350 V	200 V
1.0 MΩ	350 V	200 V
2.0 MΩ	350 V	---
2.5 MΩ	350 V	---

RVC6 N Y A 500 B

STYLE: The three-letter symbol "RVC" identifies composition, variable resistors; the single number identifies the size and power rating.

BUSHING: The single-letter symbol identifies the type of mounting bushing as follows:

- L - - Locking bushing
- N - - Standard bushing

TEMPERATURE AND MOISTURE RESISTANCE CHARACTERISTIC: The single-letter symbol "Y" identifies the maximum ambient operating temperature (125°C, full rated load; 175°C, zero load) and moisture characteristic as follows:

1/ Resistance-temperature coefficient - ±250 ppm/°C

Resistance-moisture characteristic - ±2 percent maximum allowable change in total resistance

OPERATING SHAFT: The single-letter symbol identifies the operating shaft length as follows:

- A - - - 5/8 inch, screwdriver slot (locking bushing type L)
- D - - - 7/8 inch, knob (standard bushing type N)
- L - - - 3/8 inch, screwdriver slot (standard bushing type N)

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:

500- - - - -	50 ohms
501- - - - -	500 ohms
502- - - - -	5,000 ohms

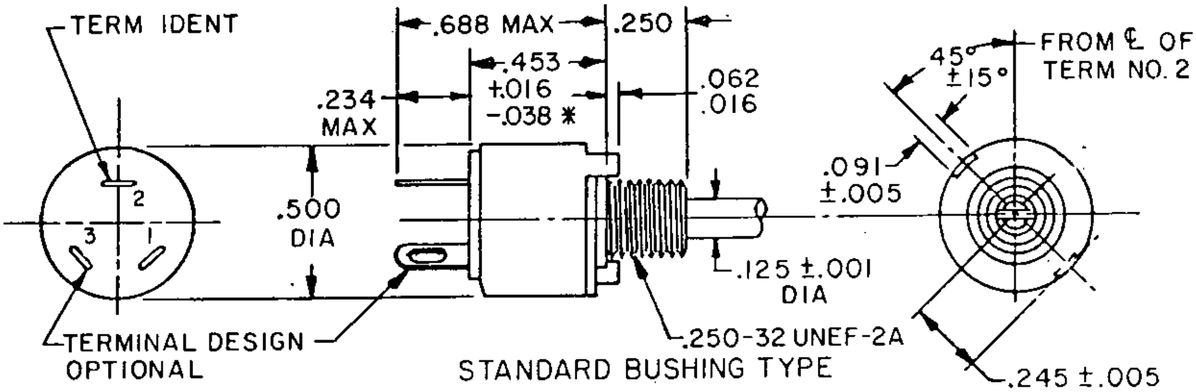
RESISTANCE CHARACTERISTIC: The single-letter symbol identifies the resistance characteristic as follows:

- B - - - Taper A (linear CW), ±10 percent resistance tolerance
- C - - - Taper C (10 percent CW) ±10 percent resistance tolerance

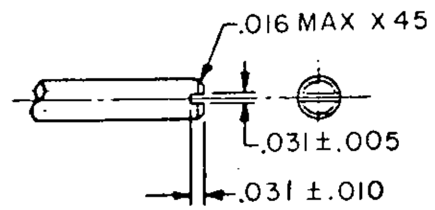
1/ Allowable change in resistance at -65°C to +175°C.

FIGURE 208-3. Type designation example.

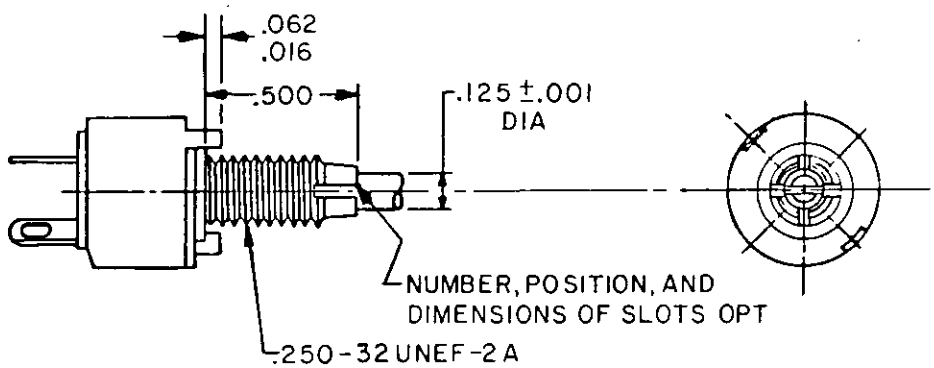
STYLE RVC6



Inches	mm	Inches	mm
.001	.03	.125	3.18
.005	.13	.234	5.94
.010	.25	.245	6.22
.016	.41	.250	6.35
.031	.79	.453	11.51
.038	.97	.500	12.70
.062	1.57	.688	17.48
.091	2.31		



SLOTTED SHAFT



LOCKING BUSHING TYPE

NOTE: Unless otherwise specified, tolerance is ±.016 (.41 mm).

FIGURE 208-4. Non-wirewound variable resistors.

TABLE 208-I. Performance characteristics.

Features	RVC6
Type bushing and symbol	Standard (N) Locking (L)
Style shaft	Slotted
Length	5/8 in. (L bushing) 3/8 and 7/8 in. (N bushing)
Maximum resistance-temperature coefficient in ppm/°C (referred to 25°C)	±250
Maximum ambient temperature at rated wattage	125°C
Maximum ambient temperature at zero wattage derating	175°C
Power rating (in watts)	1/2 watt (taper A) 1/4 watt (taper C)
Minimum resistance value (ohms)	100
Maximum resistance value (megohms)	2.5
Resistance tolerance (± percent)	10
Maximum percent change in resistance (±):	
Contact resistance variation	3 percent
Resistance to soldering heat	1 percent
Rotational life	
1,000 cycles (max cycle for T)	2 percent
25,000 cycles	4 percent
50,000 cycles	5 percent
Life	3 percent
Moisture-resistance	2 percent
Low-temperature operation	1 percent
Temperature cycling	1 percent
High-temperature exposure	4 percent
Shock (specified pulse)	2 percent
Vibration, high frequency	2 percent
Insulation resistance (wet)	100 megohms min
Max weight (grams)	25
Operating torque:	
Minimum	.5 inch-ounce min
Maximum	6 inch-ounces max
Stop	3 inch-pounds
Total mechanical rotation	292° to 298°

SECTION 209

RESISTORS, VARIABLE, NON-WIREWOUND, PRECISION

STYLES RQ090, RQ100, RQ110, RQ150, RQ160, RQ200, RQ210, AND RQ300

(APPLICABLE SPECIFICATION: MIL-R-39023)

1. SCOPE. This section covers precision, non-wirewound, variable resistors whose electrical output (in terms of percent of applied voltage) is linear with respect to the angular position of the operating shaft. These resistors are capable of full-load operation at a maximum ambient temperature of 70°C and are suitable for continuous operation, when properly derated, at a maximum temperature of 125°C. These resistors are available with an initial resistance tolerance of ±10 percent.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have a resistance element usually consisting of carbon, cermet, or conductive plastic 1/ deposited on a plastic insulating base. The moving contact is insulated from the operating shaft and maintains continuous electrical travel throughout the entire mechanical travel. The element and contact arm are enclosed in an environmentally resistant housing.

2.1.2 Selection of a safe resistor style. The wattage rating of these resistors is based on operation at 70°C, mounted on a 4-inch square, .250-inch thick alloy aluminum panel. This mounting technique should be taken into consideration when a wattage is dissipated during specific applications.

2.1.3 Derating at high temperature. These resistors may be used at the full nominal wattage at an ambient temperature of 70°C. When a resistor is to be used where the surrounding temperature is higher than 70°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the derating curve shown on figure 209-1.

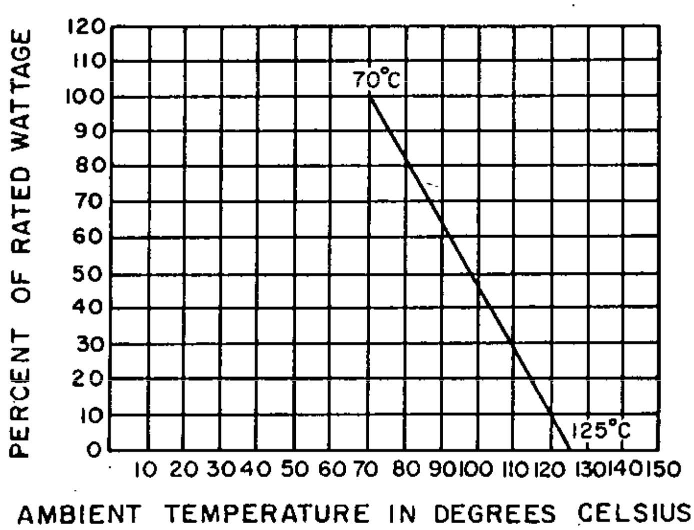


FIGURE 209-1. Derating curves for high ambient temperatures.

1/ Conductive plastic is a generic term covering a broad category of materials and manufacturing methods. It includes the "bulk" type compression molded materials and the oven cured thick films (screened, sprayed, dip coated, roll coated). All of these conductive plastic materials invariably utilize carbon as the resistive material together with a resin binder and an inert filler.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor having an adequate wattage rating.

2.1.5 Resistance-temperature characteristic. Consideration should be given to temperature rise and ambient temperature of resistors under operation, in order to allow for the change in resistance due to resistance-temperature characteristic.

2.1.6 Definitions. Definitions of the special characteristics and parameters of these potentiometers are contained in MIL-R-39023.

3. ITEM IDENTIFICATION (see figures 209-2 and 209-3).

3.1 Type designation. The type designation is used for describing the resistor as shown on figure 209-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 209-I.

3.3 Preferred values. The preferred nominal resistance values are as follows:

Nominal total resistance value	
Ohms	Megohms
100	.100
200 1/	.200
500	.500
1,000 2/	1.000
2,000	2.000
5,000	2.000
10,000	3.000
20,000	
50,000	

1/ Not available for styles RQ150, RQ200, and RQ300.
2/ Minimum resistance value for styles RQ100, RQ160, and RQ300.

The maximum value applicable to each style shall be as listed in table 209-I.

RQ090 A A 1 3 A A 101

STYLE: The two-letter symbol "RQ" identifies precision, non-wirewound, variable resistors; the number identifies the physical size.

RESISTANCE-TEMPERATURE CHRST., MAX AMBIENT TEMPERATURE, AND TAPS: The single-letter symbol identifies a ±5Δ max resistance change; 70°C (max ambient temperature at rated load), 125°C (max ambient temperature with zero load); and taps located at center of resistance element as follows:

A - - - - - Not applicable.
B - - - - - Applicable.

SHAFT LENGTH: The single-letter symbol identifies the shaft length (±1/32 inch) as follows:

A - - - - -	3/8	D - - - - - -	3/4
B - - - - -	1/2	E - - - - - -	7/8
C - - - - -	5/8	F - - - - - -	1

MOISTURE RESISTANCE: The single-digit number identifies the moisture resistance characteristic (total ΔR) as follows:

1 - - - - - - ±5 percent
2 - - - - - - ±10 percent
3 - - - - - - ±25 percent

LIFE CHRST.: The single-digit number identifies the life chrst. (total number of revolutions and dither life (in hr)) as follows:

1 - - - - - - 2.5×10^5 rev; 0.5 hr
2 - - - - - - 1×10^6 rev; 2 hr
3 - - - - - - 5×10^6 rev; 10 hr
4 - - - - - - 25×10^6 rev; 50 hr

FUNCTION-CONFORMITY TOLERANCE CHRST.: The single-letter symbol identifies the function-conformity tolerance (± percent) as follows:

A - - - - - 1.0 initial; 1.5 degraded
B - - - - - 0.5 initial; 0.75 degraded
C - - - - - 0.25 initial; 0.375 degraded
D - - - - - 0.10 initial; 0.15 degraded
E - - - - - 0.05 initial; 0.075 degraded
F - - - - - 0.025 initial; 0.038 degraded

OUTPUT-SMOOTHNESS CHRST.: The single-letter symbol identifies the peak-to-peak voltage (E_0/E_{in}) (in percent) as follows:

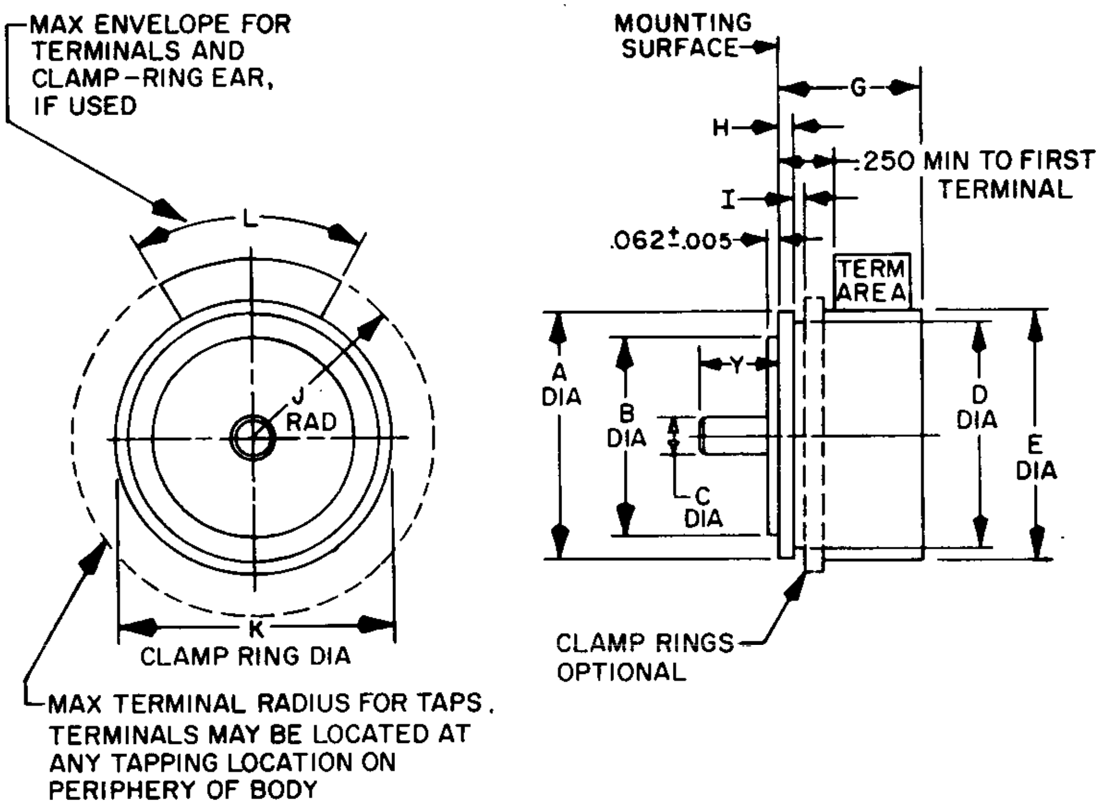
A - - - - - 2.0 initial; 2.2 degraded
B - - - - - 0.5 initial; 0.7 degraded
C - - - - - 0.1 initial; 0.15 degraded
D - - - - - 0.025 initial; 0.04 degraded
E - - - - - 0.01 initial; 0.02 degraded

RESISTANCE: The three-digit number identifies the nominal total resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:
101- - - - - 100 ohms
201- - - - - 200 ohms
102- - - - - 1,000 ohms

FIGURE 209-2. Type designation example.

STYLES RQ090, RQ100, RQ110, RQ150,
RQ160, RQ200, RQ210, AND RQ300



Style	Dimensions										
	A +.005(.13) -.010(.25)	B -.0005 (.01)	C -.0005 (.01)	D Max	E Max	G Max	H ±.005 (.13)	I Min	J Max	K Max	L Max
RQ090	.875 (22.22)	.7500 (19.05)	.1250 (3.17)	.781 (19.84)	.906 (23.01)	.81 (20.6)	.062 (1.57)	.057 (1.45)	.656 (16.66)	1.062 (26.97)	105°
RQ100	.875 (22.22)	.7500 (19.05)	.1250 (3.17)	.781 (19.84)	.906 (23.01)	1.88 (47.7)	.062 (1.57)	.057 (1.45)	.656 (16.66)	1.062 (26.97)	105°
RQ110	1.062 (26.97)	.9688 (24.6)	.1250 (3.17)	.975 (24.76)	1.125 (28.57)	.81 (20.6)	.062 (1.57)	.057 (1.45)	.781 (19.84)	1.125 (28.57)	100°
RQ150	1.437 (36.50)	1.3125 (33.34)	.2500 (6.35)	1.313 (33.35)	1.468 (37.29)	1.06 (26.9)	.093 (2.36)	.073 (1.85)	1.094 (27.79)	1.625 (41.27)	↓
RQ160	1.437 (36.50)	1.3125 (33.34)	↓	1.313 (33.35)	1.468 (37.29)	2.50 (63.5)	↓	↓	1.094 (27.79)	1.625 (41.27)	↓
RQ200	2.000 (50.80)	1.8750 (47.62)	↓	1.875 (47.62)	2.031 (51.59)	1.31 (33.3)	↓	↓	1.375 (34.92)	2.250 (57.15)	↓
RQ210	2.000 (50.80)	1.8750 (47.62)	↓	1.875 (47.62)	2.031 (51.59)	2.90 (73.7)	↓	↓	1.375 (34.92)	2.250 (57.15)	↓
RQ300	3.000 (76.20)	2.8750 (73.02)	↓	2.875 (73.02)	3.031 (76.97)	1.31 (33.3)	↓	↓	1.750 (44.45)	3.250 (82.55)	90°

NOTE: For dimension Y, see shaft length (figure 209-2).

FIGURE 209-3. Non-wirewound, precision, variable resistors.

TABLE 209-I. Performance characteristics.

Features	Style							
	RQ090	RQ100	RQ110	RQ150	RQ160	RQ200	RQ210	RQ300
Shaft length	3/8, 1/2, 5/8, 3/4			3/8, 1/2, 5/8, 3/4, 7/8, 1				
Diameter	.125	.125	.125	.125	.250	.250	.250	.250
Cup diameter	7/8	7/8	1 1/16	1 7/16	1 7/16	2	2	3
Resistance range Maximum	1 MΩ	1 MΩ	1 MΩ	1 MΩ	3 MΩ	1 MΩ	3 MΩ	1 MΩ
Resistance range Minimum	100	1,000	100	100	1,000	100	1,000	100
Power rating at 70°C	1.0	2.5	1.25	1.5	3.5	2.0	4.5	3.0
Power rating at 125°C	0	0	0	0	0	0	0	0
Maximum continuous working voltage	250	500	250	250	500	250	500	250
Maximum starting and running torque in inch-ounce (single turn, single cup) Starting	0.5		0.5	1.0		1.5		1.5
Running	0.4		0.4	0.8		1.0		1.0
Travel (degrees) Electrical	320°	3,600°	340°	340°	3,600°	350°	3,600°	350°
Mechanical	360°	3,600°	360°	360°	3,600°	360°	3,600°	360°
Weight - Basic (oz, max)	1.0	1.5	1.25	3.0	5.0	5.0	8.0	10.0
Insulation resistance	1,000 megohms initial; 500 megohms degradation							
Dielectric withstanding voltage	No damage, arcing, etc; 1 mA leakage current							
Terminal strength	No mechanical or electrical damage							
Temperature cycling	±10 percent ΔR							
Rotational load life	±10 percent ΔR							
Low temperature operation	±5 percent ΔR							
Low temperature exposure	1/							
High temperature exposure	1/							
Shock	No mechanical or electrical damage or momentary discontinuity greater than 0.1 ms							
Vibration, high frequency	±2 percent ΔR							
Salt spray (corrosion)	No appreciable corrosion							

1/ The change in output ratio shall not exceed the applicable degraded function conformity tolerance or 0.5 percent, whichever is greater.

SECTION 300

RESISTORS, FIXED, ESTABLISHED RELIABILITY

SECTION 301

RESISTORS, FIXED, COMPOSITION (INSULATED), ESTABLISHED RELIABILITY

STYLES RCR05, RCR07, RCR20, RCR32, AND RCR42

(APPLICABLE SPECIFICATION: MIL-R-39008)

1. SCOPE. This section covers established reliability, insulated, fixed resistors, having a composition resistance element and axial leads. These resistors provide life failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours at 50 percent of full-load operation at an ambient temperature of 70°C. The failure rates are established at a 60 percent confidence level and maintained at a 10 percent producer's risk. The failure rate is referred to operation at one-half rated wattage and temperature with a maximum change in resistance of ±15 percent at 0 to 10,000 hours of life test.

2. APPLICATION INFORMATION.

2.1 Construction. In these resistors the resistance element consists of a mixture of carbon, insulating material, and suitable binders, either molded together or applied as a thin layer of conducting material on an insulated form. These resistors are covered by a molded jacket which is primarily intended to provide an adequate moisture barrier for the resistance element, as well as mechanical protection and strength. Due to the reliability requirements of MIL-R-39008, processes and controls utilized in manufacturing are necessarily more stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of these requirements.

2.2 Derating. Consideration must be given to the resistor's wattage rating. This is based on the materials used and is controlled by specifying a maximum hot-spot temperature. The amount of dissipation that can be developed in a resistor body at the maximum hot-spot temperature depends upon how effectively the dissipated energy is carried away and therefore, it is also a direct function of the ambient temperature. To be operated continuously at full rating, the resistor must be connected to an adequate heat sink, which means approximately 1/2-inch leads connected to average size solder terminals with no other dissipative parts connected to the same terminals or mounted closer than one diameter. Appropriate derating must be imposed at elevated temperatures. Power dissipation capabilities of a resistor are usually lower when mounted in equipment than under test conditions. Most of the generated heat is carried away by the resistor leads; therefore, when two resistors are connected to the same terminal, wattage ratings would be decreased approximately 25 percent. Close proximity of one resistor to another, or to any other heat generating part, further reduces the wattage rating. Conformal coatings and encapsulating materials are poor heat conductors. When resistors are packaged in this manner, exercise caution in selection of the power rating.

2.3 Derating at high temperatures. The power rating is based on operation at 70°C; however, when a resistor is to be used in a circuit where the surrounding temperature is higher than 70°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the curve shown on figure 301-1.

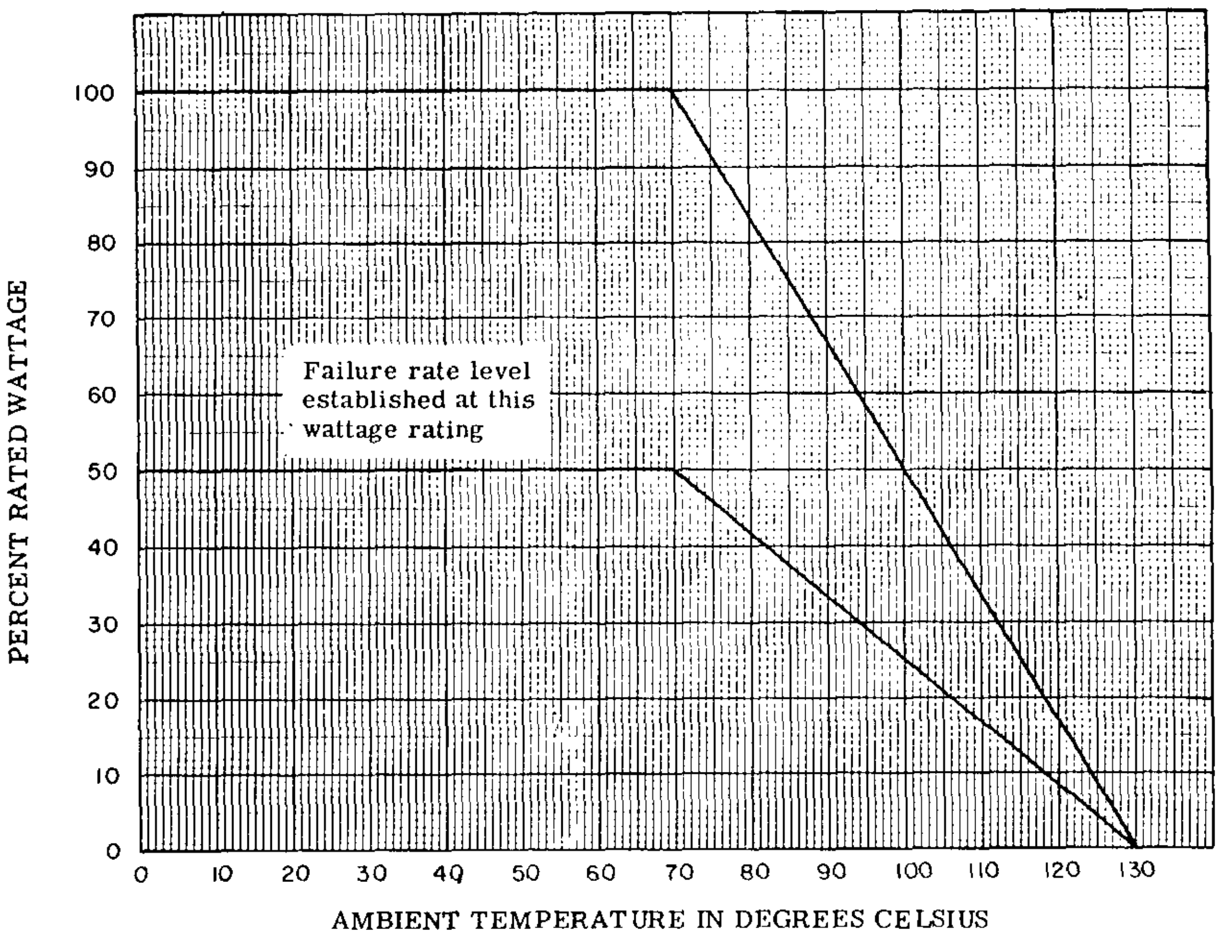
2.4 Derating for optimum performance. For optimum performance, two "rules of thumb" have been in practice in industry for these resistors - they are:

a. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 is applied to the wattage.

b. Wattage is adjusted so that the hot-spot temperature does not exceed the following for the particular style.

120°C - RCR05 and RCR07
100°C - RCR20, RCR32, and RCR42

NOTE: It is recommended that either of the above techniques be considered in the application of these resistors.



NOTE: It is essential that these resistors operate at no more than 50 percent of rated wattage if the failure rate level is to be maintained.

FIGURE 301-1. Derating curve for high ambient temperature.

TABLE 301-I. Resistance-temperature characteristic.

Maximum ambient operating temperature (100 percent rated wattage and 50 percent rated wattage for FR determination)	Nominal resistance	Maximum allowable change in resistance from resistance at 25°C ambient temperature	
		At -55°C (ambient)	At +105°C (ambient)
70°C	1,000Ω and under	±6.5 percent	±5 percent
	1,100Ω to 10,000 MΩ incl	±10 percent	±6 percent
	11,000Ω to 0.10 MΩ incl	±13 percent	±7.5 percent
	0.11 MΩ to 1.0 MΩ incl	±15 percent	±10 percent
	1.1 MΩ to 10 MΩ incl	±20 percent	±15 percent
	11.0 MΩ and over	±25 percent	±15 percent

2.5 Peak voltages and pulsed operation. When composition resistors are used under low-duty-cycle pulse conditions, the maximum permissible operating voltage is limited by breakdown rather than by heating. In such applications the peak value of the pulse should not exceed 2.5 times the rated rms working voltage or the maximum overload voltage per table 301-II, whichever is less. If the pulses are of sufficient duration to raise the resistors temperature excessively, the resistor must be derated even though the interval between pulses may be long enough to make the average heating small.

TABLE 301-II. Maximum overload voltage.

Power rating	Maximum overload voltage (dc or peak ac)
Watts	Volts
1/8	200
1/4	400
1/2	700
1	1,000
2	1,000

2.6 Noise. Thermal agitation or Johnson noise and resistance fluctuation or carbon noise, present only when current is flowing, are characteristic of carbon composition resistors. Use of these resistors in low level high-resistance (1 megohm or more) circuits should be avoided. Noise which can be expected is approximately 3 to 10 microvolts per volt. A film or wirewound resistor will usually yield more satisfactory results.

2.7 Moisture resistance. When exposed to humid atmosphere while dissipating less than 10 percent of rated voltage (including shelf storage, equipment nonoperating, and shipping conditions), resistance values may change 15 percent.

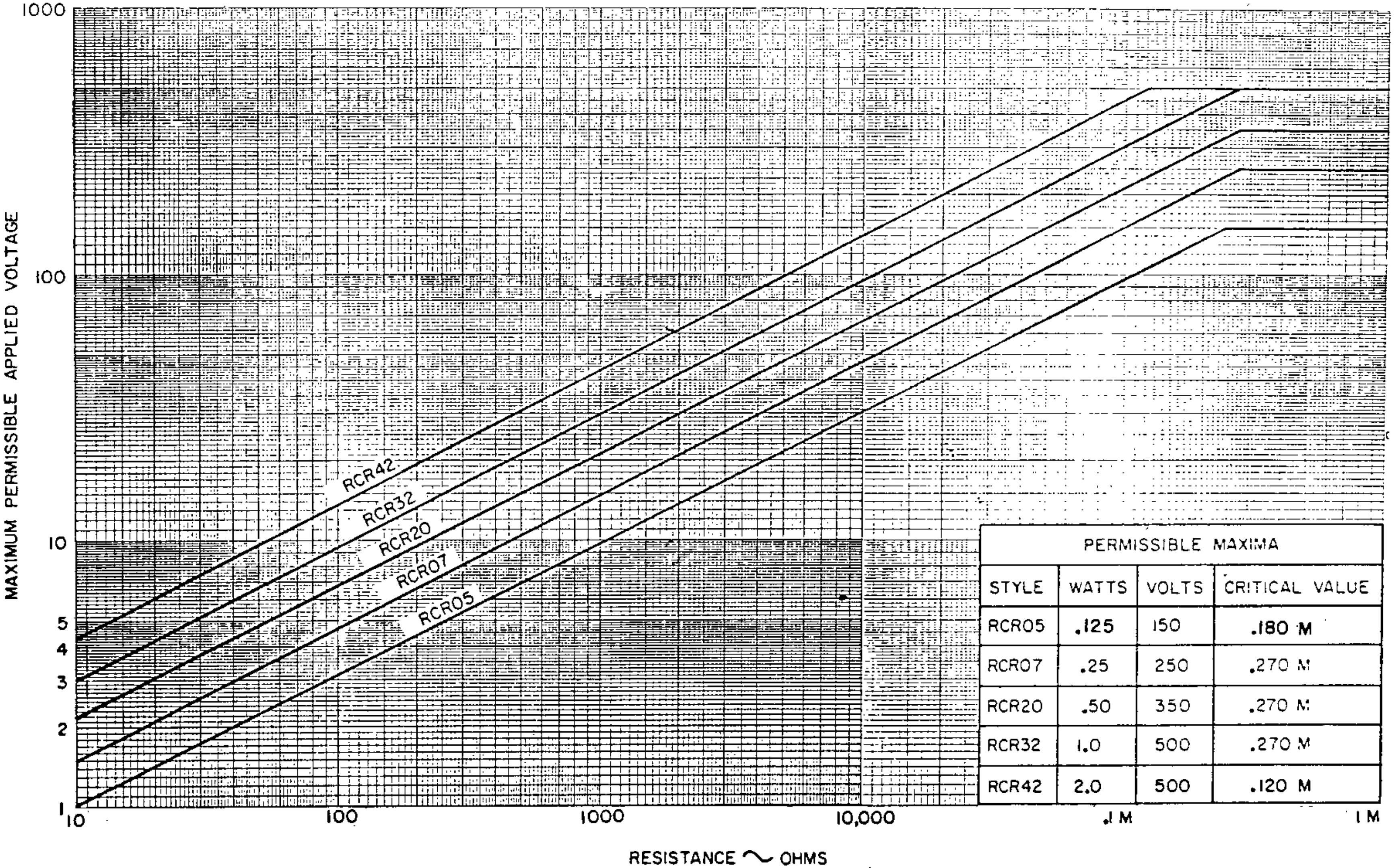
2.8 Maximum rated voltage. The fact that there are voltage limits in the application of fixed composition resistors is often overlooked. These maximum rated applied voltages, which are imposed because of insulation breakdown problems, must be taken into consideration in addition to the limitations of power dissipation. Figure 301-2 illustrates the maximum voltages for various sizes (wattage ratings) of composition resistors.

2.9 High frequency applications. When used in high frequency circuits (100 kHz and above), the effective resistance will decrease as a result of dielectric losses and shunt capacity (both end-to-end and distributed capacity to mounting surface). High frequency characteristics of carbon composition resistors are not controlled by specification and hence are subject to change without notice. Typical values of impedance to dc resistance ratio and phase angle from 100 kHz to 100 MHz are shown in Figures 301-6 through 301-15 for 1/8 watt, 1/4 watt, 1/2 watt, 1 watt, and 2 watt type composition resistors. Circuit variations in mounting position and lead length can have a significant effect on the high frequency characteristics.

2.10 Voltage coefficient. When voltage is applied to carbon composition resistors, resistance values may change by 2 percent, or by 0.05 percent per volt for resistors above 1,000 ohms for style RCR05, 0.035 percent per volt for resistors above 1,000 ohms for styles RCR07 and RCR20, and 0.02 percent per volt above 1,000 for styles RCR32 and RCR42. The voltage coefficient for resistors below 1,000 ohms is not controlled by specification and these resistors should not be used in circuits which are sensitive to this parameter.

2.11 Temperature-resistance. The resistance-temperature variation of carbon composition resistors cannot be defined by a temperature coefficient since the variation is not only nonlinear but is a different shape for different resistance values. (See table 301-I.)

2.12 Shelf life. In general, these resistors exhibit resistance variations in shelf life as high as +15 percent due to moisture and temperature effects. When a closer life tolerance or higher accuracy is needed, resistors per MIL-R-55182 or MIL-R-39017, should be used.



PERMISSIBLE MAXIMA			
STYLE	WATTS	VOLTS	CRITICAL VALUE
RCR05	.125	150	.180 M
RCR07	.25	250	.270 M
RCR20	.50	350	.270 M
RCR32	1.0	500	.270 M
RCR42	2.0	500	.120 M

FIGURE 301-2. Voltage limitations by style.

2.13 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 closely to a resistor body or for too long a period. The length of lead left between the resistor body and the soldering point should not be less than 1/4 inch. Heat-dissipating clamps should be used, if necessary, when soldering resistors in close quarters. In general, if it is necessary to unsolder a resistor to make a circuit change or in maintenance, the resistor should be discarded and a new one used.

2.14 Maximum weight. The maximum weight of each style is as follows:

RCR05 - - - - - -	0.080 gram
RCR07 - - - - - -	0.300 gram
RCR20 - - - - - -	0.662 gram
RCR32 - - - - - -	1.533 grams
RCR42 - - - - - -	3.000 grams

2.15 Conditioning. For conditioning purposes, all units furnished under MIL-R-39008 are conditioned at 100°C for 96 ±4 hours.

2.16 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±15 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

2.17 Life degradation. The curve on figure 301-3 was established from percent change in resistance requirements of MIL-R-39008.

2.18 Out-of-tolerance resistors. Resistance shifts due to absorption of moisture are inherent in carbon-composition resistors. Before being considered failures, out of tolerance resistors should be conditioned in a dry oven at a temperature of 100 ±5°C for the duration shown below prior to conducting resistance measurements.

Style RCR05 -	25 ±4 hours
Style RCR42 -	130 ±4 hours
All other styles- - - - - - - - - - - - - - - - - - - -	96 ±4 hours

Resistors which continue to be out of tolerance after the above conditioning process should be considered failures.

3. ITEM IDENTIFICATION (see figures 301-4 and 301-5).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 301-4.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 301-III.

3.3 Resistance values. The values shall follow the decade of values as shown in the following:

Resistance values for the 10 to 100 decade					
Resistance tolerance					
J (5.0)	K (10.0)	J (5.0)	K (10.0)	J (5.0)	K (10.0)
10	10	22	22	47	47
11	--	24	--	51	--
12	12	27	27	56	56
13	--	30	--	62	--
15	15	33	33	68	68
16	--	36	--	75	--
18	18	39	39	82	82
20	--	43	--	91	--

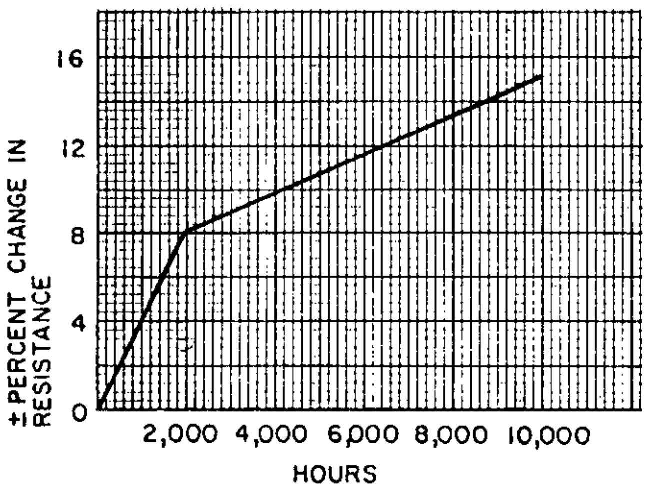


FIGURE 301-3. Life test degradation curve.

RCR07 G 470 J M

STYLE: The three-letter symbol "RCR" identifies established reliability, insulated, composition, fixed resistors; the two-digit number identifies the size and power rating.

CHARACTERISTIC: The single-letter symbol "G" identifies the resistance-temperature characteristics as shown in table 301-I.

RESISTANCE: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros
* to follow. For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

2R7 - - - - -	2.7 ohms
100 - - - - -	10 ohms
105 - - - - -	1 megohm
226 - - - - -	22 megohms

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

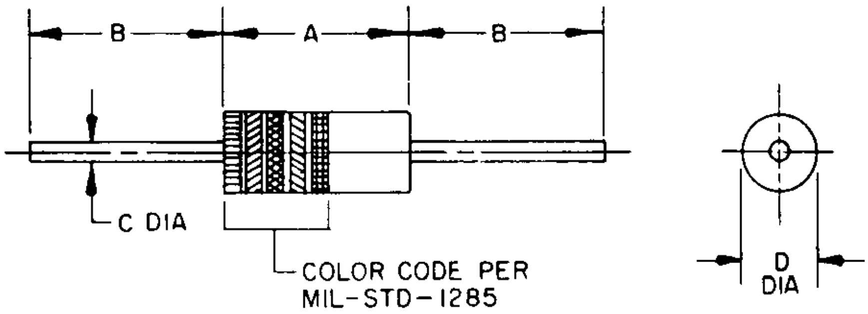
J - - - -	±5 percent
K - - - -	±10 percent

FAILURE RATE LEVEL: The single-letter symbol identifies the failure rate as follows:

M - - - -	1.0 percent/1,000 hr
P - - - -	0.1 percent/1,000 hr
R - - - -	0.01 percent/1,000 hr
S - - - -	0.001 percent/1,000 hr

FIGURE 301-4. Type designation example.

STYLES RCR05, RCR07, RCR20, RCR32, AND RCR42



Inches	mm	Inches	mm
.002	.05	.062	1.57
.003	.08	.090	2.29
.004	.10	.125	3.18
.005	.13	.138	3.51
.008	.20	.145	3.68
.015	.38	.225	5.72
.018	.46	.250	6.35
.023	.58	.318	8.08
.025	.64	.375	9.53
.031	.79	.562	14.27
.040	1.02	.688	17.48
.041	1.04	1.000	25.40
.045	1.14	1.500	38.10

Standard style	Dimensions (inches)			
	A	B±.125	C	D
RCR05	.145±.015	1.000	.015±.003	.062±.004
RCR07	.250±.031	1.500	.025±.002	.090±.008
RCR20	$.375^{+.041}_{-.031}$	1.500	.031±.005	.138±.023
RCR32	.562±.031	1.500	.040±.005	.225±.015
RCR42	.688±.040	1.500	.045±.003	.318±.018

FIGURE 301-5. Insulated, composition, fixed resistors.

TABLE 301-III. Performance characteristics.

Features	Style RCR05	RCR07	RCR20	RCR32	RCR42
Power rating (at 70°C):					
100 percent load (watts)	1/8	1/4	1/2	1	2
50 percent load/FR level determination (watt)	1/16	1/8	1/4	1/2	1
Max operating voltage (volts)	150	250	350	500	500
Resistance tolerance (± percent)	5, 10	5, 10	5, 10	5, 10	5, 10
Min resistance (ohms)	2.7	2.7	1.0	1.0	10
Max resistance (megohms)	22	22	22	22	22
Dielectric withstanding voltage (volts rms):					
Atmospheric pressure	300	500	700	1,000	1,000
Barometric pressure	200	325	450	625	625
Insulation resistance (min):					
Dry (initial) (megohms)	10 kΩ	10,000	10,000	10,000	10,000
Wet (after moisture resistance) (megohms)	100	100	100	100	100
Terminal strength (pull) (lbs)	2	5	5	5	5
Voltage coefficient 1/ (max ±ΔR percent/volt)	0.05	0.035	0.035	0.02	0.02
Max percent change in resistance (±) 2/:					
Low temperature operation	3.0	3.0	3.0	3.0	3.0
Low temperature storage	3.0	3.0	3.0	3.0	3.0
Temperature cycling	4.0	4.0	4.0	4.0	4.0
Moisture resistance/resistor	15	15	15	15	15
Short-time overload	2.5	2.5	2.5	2.5	2.5
Terminal strength (twist)	1.0	1.0	1.0	1.0	1.0
Resistance to soldering heat	3.0	3.0	3.0	3.0	3.0
Shock					
Vibration, high frequency	2.0	2.0	2.0	2.0	2.0
Life, qualification inspection:					
100 percent wattage/resistor (1,000 hr)	10	10	10	10	10
50 percent wattage (2,000 hr)	8	8	8	8	8
Failure-rate determination (10,000 hr)	15	15	15	15	15

1/ Applicable only to resistors of 1,000 ohms and over.
2/ Where total resistance change is 4 percent or less, it shall be considered as ± (__ percent +0.05 ohm).

NOTE: All leads are solderable in accordance with method 208 of MIL-STD-202.

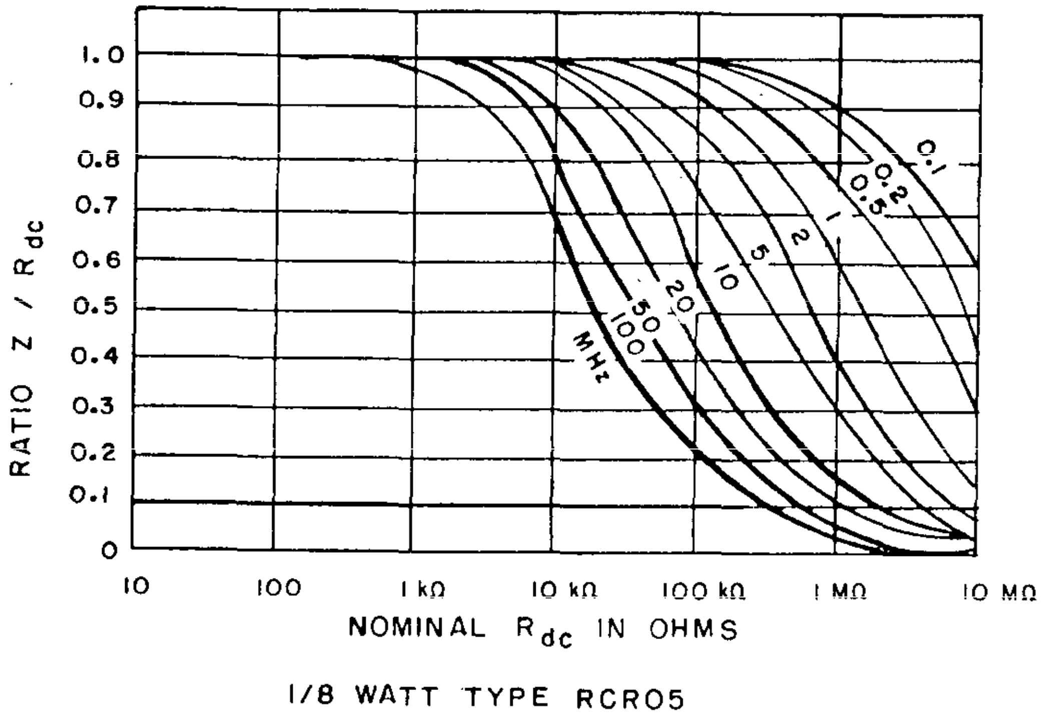


FIGURE 301-6. Impedance to dc resistance ratio.

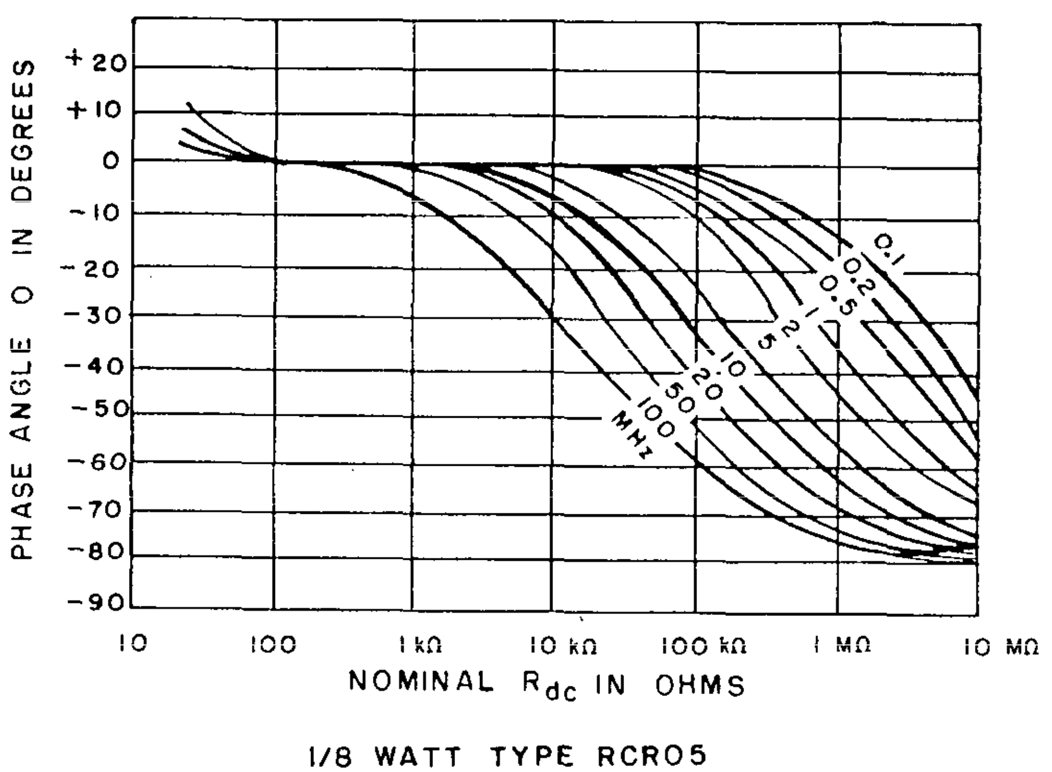


FIGURE 301-7. Impedance to phase angle.

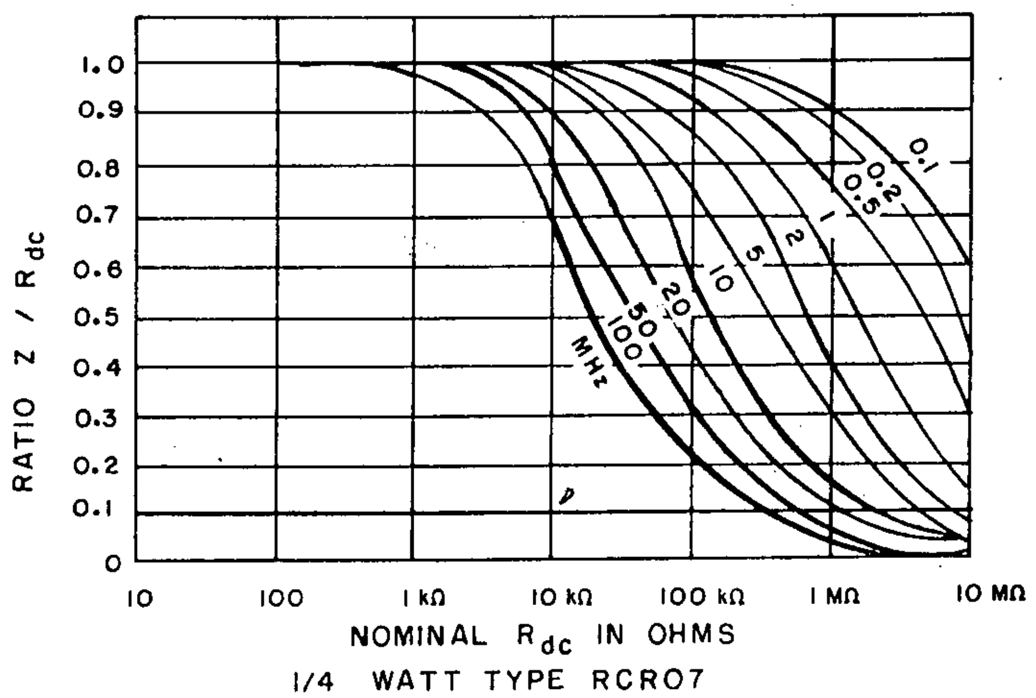
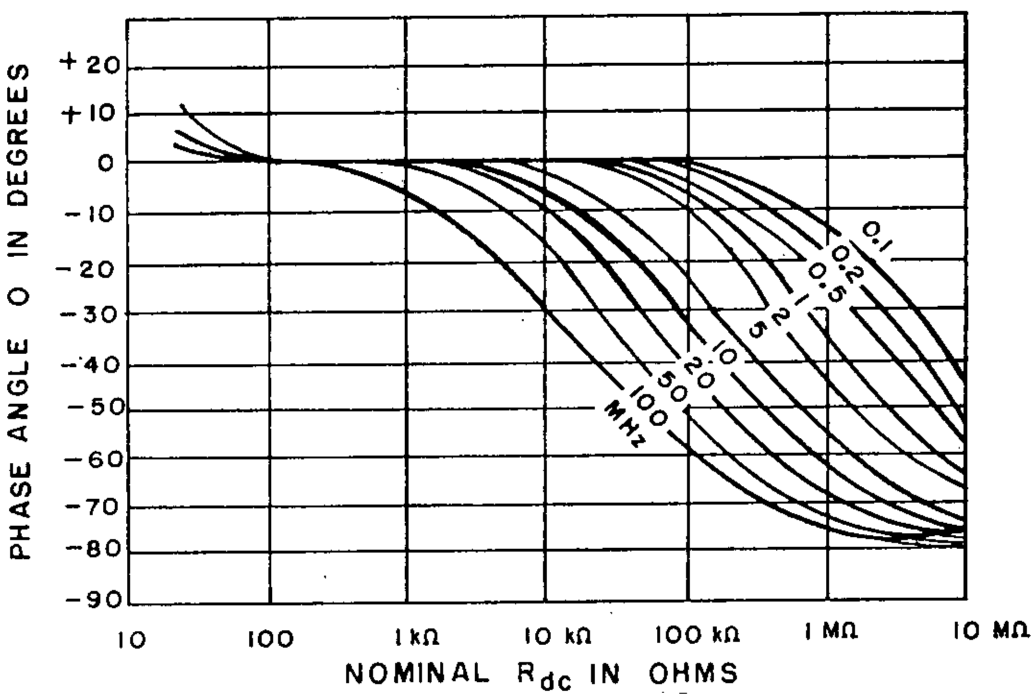
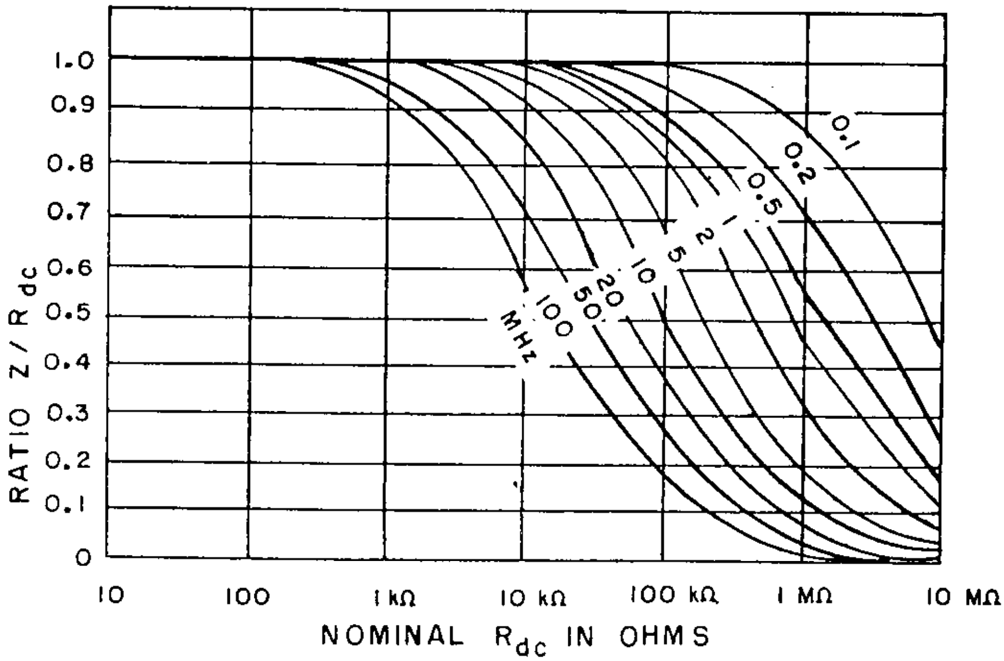


FIGURE 301-8. Impedance to dc resistance ratio.



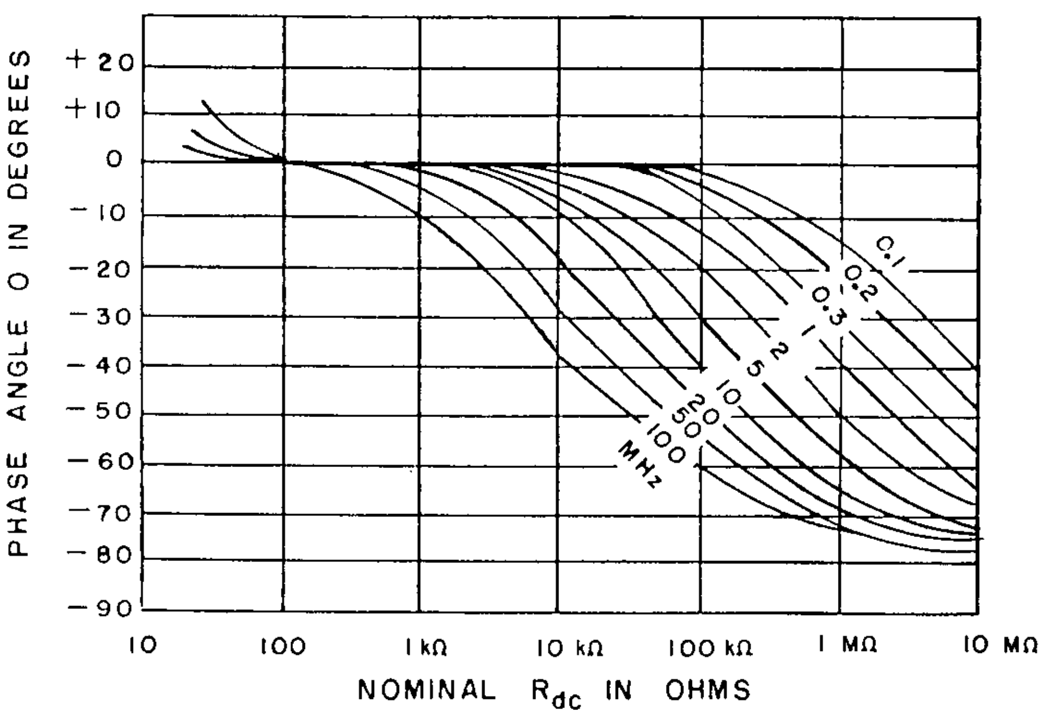
1/4 WATT TYPE RCR07

FIGURE 301-9. Impedance to phase angle.



1/2 WATT TYPE RCR20

FIGURE 301-10. Impedance to dc resistance ratio.



1/2 WATT TYPE RCR20

FIGURE 301-11. Impedance to phase angle.

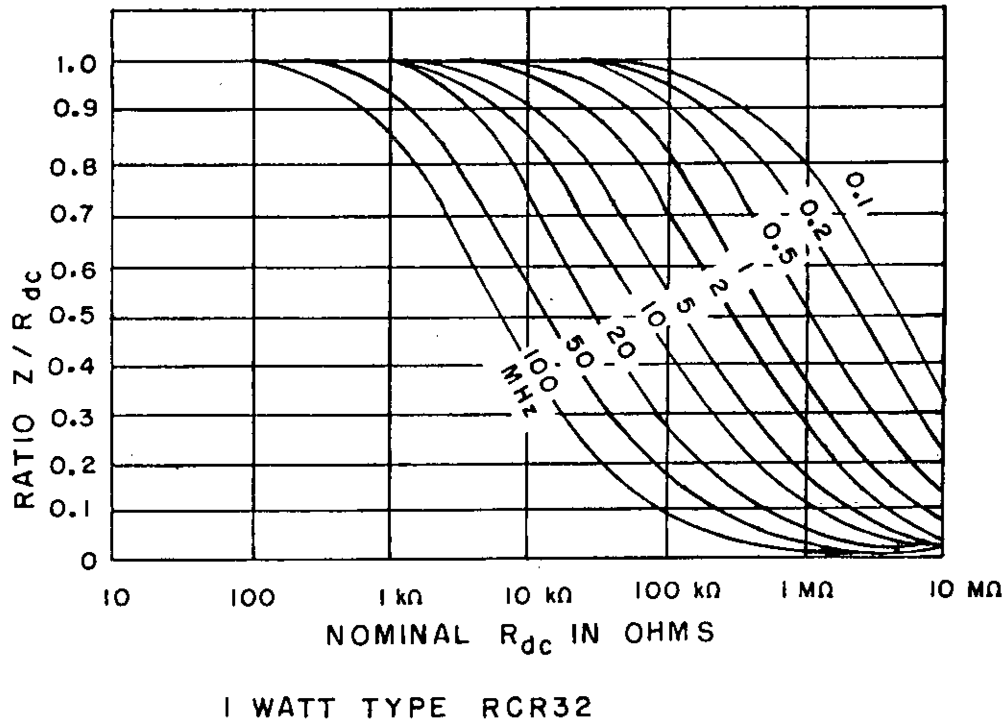


FIGURE 301-12. Impedance to dc resistance ratio.

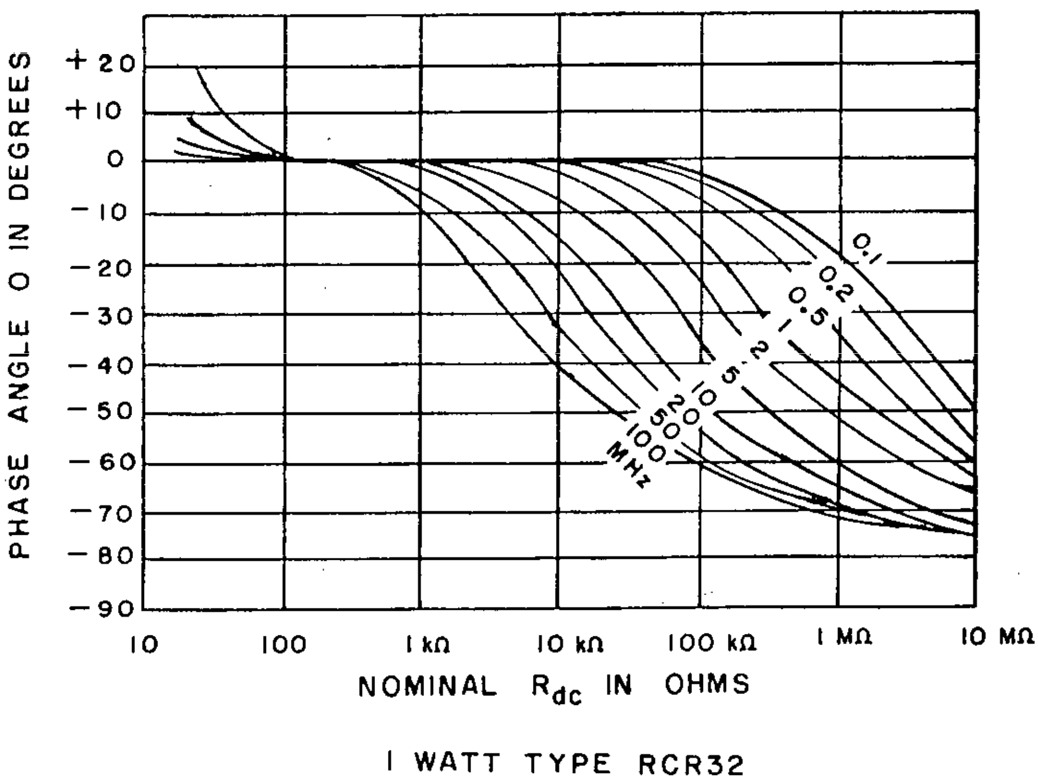
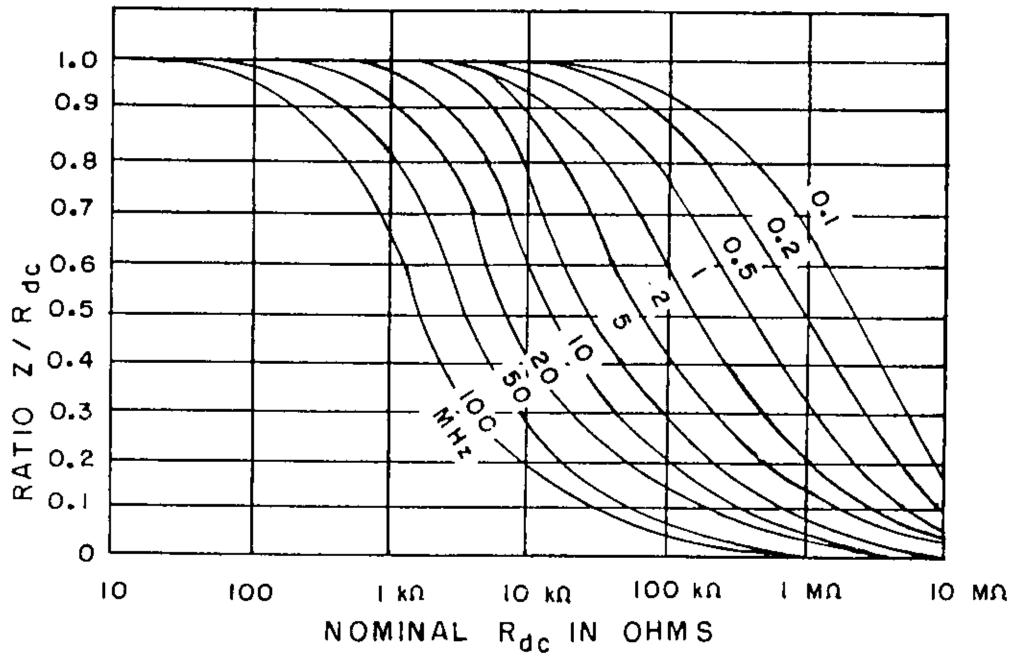
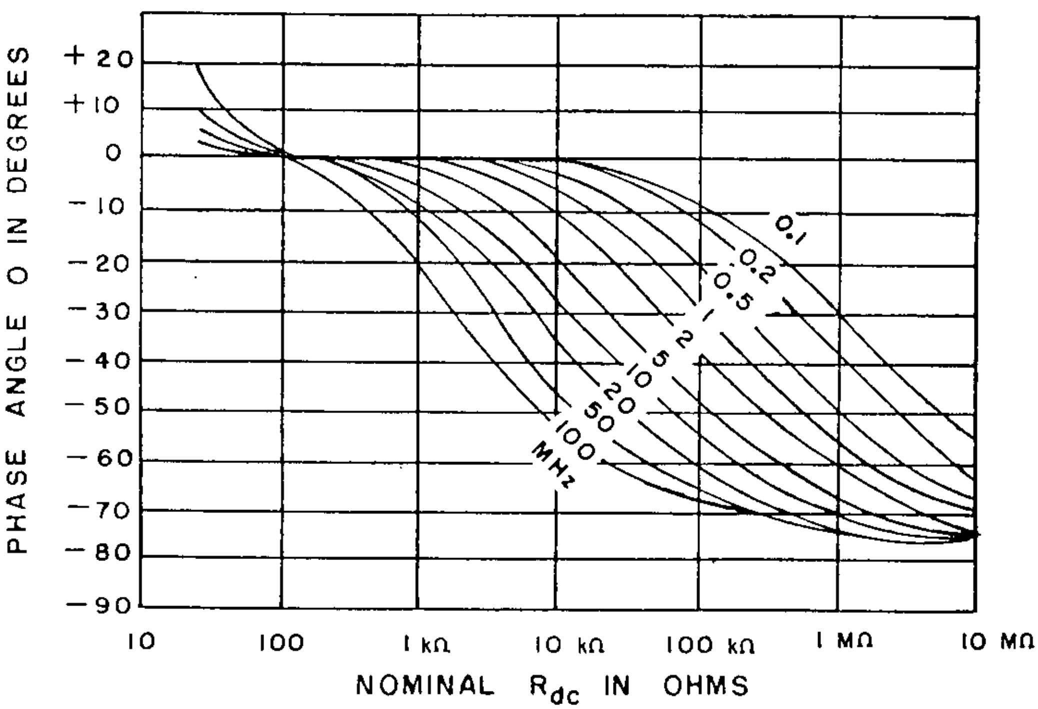


FIGURE 301-13. Impedance to phase angle.



2 WATT TYPE RCR42

FIGURE 301-14. Impedance to dc resistance ratio.



2 WATT TYPE RCR42

FIGURE 301-15. Impedance to phase angle.

SECTION 302

RESISTORS, FIXED, FILM, ESTABLISHED RELIABILITY

STYLES RNR50, RNR55, RNR60, RNR65, RNR70, RNR75, AND RNC90 1/

(APPLICABLE SPECIFICATION: MIL-R-55182)

1. SCOPE. This section covers established reliability, film, fixed resistors, including both hermetically and nonhermetically sealed types. These resistors possess a high degree of stability, with respect to time, under severe environmental conditions, with an established reliability. These resistors provide life failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level (initial qualification) and maintained at a 10-percent producer's risk. The failure rate is referred to operation at full-rated wattage and temperature with a maximum change in resistance of ±2.0 percent at 0 to 10,000 hours of life test.

These resistors are designed for use in critical circuitry where high stability, long life, reliable operation, and accuracy are of prime importance. They are particularly desirable for use in circuits where high frequencies preclude the use of other types of resistors. Some of the applications for which these film-type resistors are especially suited are as follows: high-frequency, tuned circuit loaders, television side-band filters, rhombic antenna terminators; radar pulse equipment; and metering circuits, such as impedance bridges and standing wave-ratio meters.

2. APPLICATION INFORMATION.

2.1 Construction. In these resistors the resistance element consists of a metal film element on a ceramic substrate. The element is formed by the condensation of a heated metal under vacuum conditions. Following spiralling to increase the available resistance values and the attachment of leads, the element is protected from environmental conditions by an enclosure. Due to the reliability requirements of MIL-R-55182, processes and controls utilized in manufacturing are necessarily more stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications", provides for monitoring and documentation of these requirements.

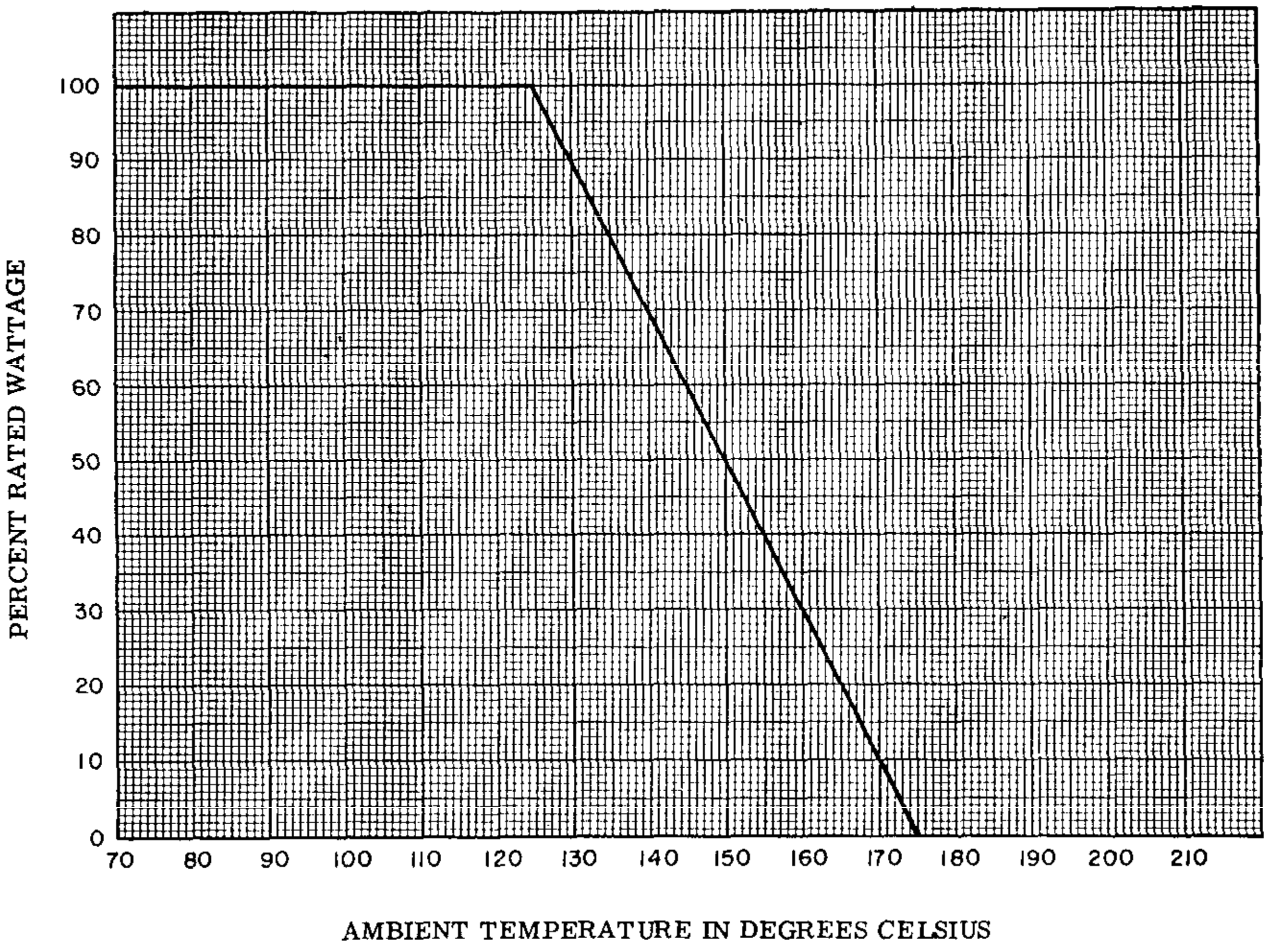
2.2 Derating at high temperatures. The power rating is based on operation at 125°C. However, when a resistor is to be used in a circuit where the surrounding temperature is higher than 125°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. The correction factor may be taken from the curve shown on figure 302-1.

2.3 Derating for optimum performance. Because all of the electrical energy dissipated by a resistor is converted into heat energy, the temperature of the surrounding air is an influencing factor when selecting a particular resistor for a specific application. The power rating of these resistors is based on operation at specific temperatures; however, in actual use, the resistor may not be operating at these temperatures. When the desired characteristic and the anticipated maximum ambient temperatures have been determined, a safety factor of 2, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential.

2.4 Design tolerance. Combined effects of use and environment may result in a ±2 percent change from nominal value in a resistor of the preferred ±1 percent nominal resistance tolerance. Circuits, therefore, should be designed to accept this ±2 percent variation in resistance while continuing to operate properly.

2.5 Moisture resistance. Metal film resistors are essentially unaffected by moisture. The specification allows only a 0.4 percent change in resistance value as a result of exposure to a standard 10-day moisture resistance test.

1/ Third letter is variable, dependent upon lead material or capability (see 3.4).



NOTE: These curves indicate the percentage of nominal wattage to be applied at temperatures higher than 125°C. However, at no time should the applied voltage exceed the maximum for each style.

FIGURE 302-1. Derating curves for high ambient temperatures.

2.6 High frequency applications. When used in high frequency circuits (400 megahertz and above), the effective resistance will decrease as a result of shunt capacity (both end-to-end and distributed capacity to mounting surface). High frequency characteristics of metal film resistors are not controlled by specification and hence are subject to change without notice.

2.7 Pulse applications. When metal film resistors are used in low duty cycle pulse circuits, peak voltage should not exceed 1.4 times the rated continuous working voltage (RCWV). However, if the duty cycle is high or the pulse width is appreciable, even though average power is within ratings, the instantaneous temperature rise may be excessive, requiring a resistor of higher wattage rating. Peak power dissipation should not exceed four times the maximum rating of the resistor under any conditions.

2.8 Voltage coefficient. The voltage coefficient for resistors of 1,000 ohms and above shall not exceed ±.005 percent per volt.

2.9 Noise. Noise output is controlled by the specification but, for metal-film resistors, noise is a negligible quantity. In applications where noise is an important factor, fixed film resistors are superior to composition types. Where noise test screening is indicated, it is recommended that the noise test procedure of MIL-STD-202 be used for resistor screening.

2.10 Mounting. Under conditions of severe shock or vibration (or a combination of both), resistors should be mounted in such a fashion that the body of the resistor is restrained from movement with respect to the mounting base. It should be noted that if clamps are used, certain electrical characteristics of the resistor will be altered. The heat-dissipating qualities of the resistor will be enhanced or retarded depending on whether the clamping material is a good or poor heat conductor.

2.11 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±2.0 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

2.12 Screening. All resistors furnished under MIL-R-55182 are subjected to conditioning through thermal shock and overload testing.

3. ITEM IDENTIFICATION (see figures 302-2 through 302-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 302-2 or figure 302-3.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 302-I.

3.3 Resistance values. Resistance values for the F (1.0 percent) and D (0.5 percent) tolerances shall follow the tabulation shown on page 302.4. Resistance values for tolerance B (0.1 percent), A (0.05 percent), T (0.01 percent), and V (0.005 percent) may be any value, but it is preferred that the values be chosen from the D tolerance values given in the tabulation.

3.4 Terminal types. Preferred lead types associated with the applicable characteristic are as follows:

Characteristic	Terminal designator	Specification indicates weldable	Specification indicates solderable
C	N (Type N-2 of MIL-STD-1276), R	N - Yes R - No	N - No R - Yes
H	C (Type C of MIL-STD-1276)	Yes	Yes
E	N (Type N-2 of MIL-STD-1276), R	N - Yes R - No	N - No R - Yes
J	C (Type C of MIL-STD-1276)	Yes	Yes
K	C (Type C of MIL-STD-1276)	Yes	Yes
Y 1/	C (Type C of MIL-STD-1276)	Yes	Yes

1/ Applicable to style RNC90 only.

Symbol	Terminal
RNR 1/	Solderable
RNC 2/	Solderable/weldable (type C of MIL-STD-1276)
RNN	Weldable (type N-2 of MIL-STD-1276)

Resistance tolerance.

D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)
10.0	10.0	17.8	17.8	31.6	31.6	56.2	56.2
10.1	---	18.0	---	32.0	---	56.9	---
10.2	10.2	18.2	18.2	32.4	32.4	57.6	57.6
10.4	---	18.4	---	32.8	---	58.3	---
10.5	10.5	18.7	18.7	33.2	33.2	59.0	59.0
10.6	---	18.9	---	33.6	---	59.7	---
10.7	10.7	19.1	19.1	34.0	34.0	60.4	60.4
10.9	---	19.3	---	34.4	---	61.2	---
11.0	11.0	19.6	19.6	34.8	34.8	61.9	61.9
11.1	---	19.8	---	35.2	---	62.6	---
11.3	11.3	20.0	20.0	35.7	35.7	63.4	63.4
11.4	---	20.3	---	36.1	---	64.2	---
11.5	11.5	20.5	20.5	36.5	36.5	64.9	64.9
11.7	---	20.8	---	37.0	---	65.7	---
11.8	11.8	21.0	21.0	37.4	37.4	66.5	66.5
12.0	---	21.3	---	37.9	---	67.3	---
12.1	12.1	21.5	21.5	38.3	38.3	68.1	68.1
12.3	---	21.8	---	38.8	---	69.0	---
12.4	12.4	22.1	22.1	39.2	39.2	69.8	69.8
12.6	---	22.3	---	39.7	---	70.6	---
12.7	12.7	22.6	22.6	40.2	40.2	71.5	71.5
12.9	---	22.9	---	40.7	---	72.3	---
13.0	13.0	23.2	23.2	41.2	41.2	73.2	73.2
13.2	---	23.4	---	41.7	---	74.1	---
13.3	13.3	23.7	23.7	42.2	42.2	75.0	75.0
13.5	---	24.0	---	42.7	---	75.9	---
13.7	13.7	24.3	24.3	43.2	43.2	76.8	76.8
13.8	---	24.6	---	43.7	---	77.7	---
14.0	14.0	24.9	24.9	44.2	44.2	78.7	78.7
14.2	---	25.2	---	44.8	---	79.6	---
14.3	14.3	25.5	25.5	45.3	45.3	80.6	80.6
14.5	---	25.8	---	45.9	---	81.6	---
14.7	14.7	26.1	26.1	46.4	46.4	82.5	82.5
14.9	---	26.4	---	47.0	---	83.5	---
15.0	15.0	26.7	26.7	47.5	47.5	84.5	84.5
15.2	---	27.1	---	48.1	---	85.6	---
15.4	15.4	27.4	27.4	48.7	48.7	86.6	86.6
15.6	---	27.7	---	49.3	---	87.6	---
15.8	15.8	28.0	28.0	49.9	49.9	88.7	88.7
16.0	---	28.4	---	50.5	---	89.8	---
16.2	16.2	28.7	28.7	51.1	51.1	90.9	90.9
16.4	---	29.1	---	51.7	---	92.0	---
16.5	16.5	29.4	29.4	52.3	52.3	93.1	93.1
16.7	---	29.8	---	53.0	---	94.2	---
16.9	16.9	30.1	30.1	53.6	53.6	95.3	95.3
17.2	---	30.5	---	54.2	---	96.5	---
17.4	17.4	30.9	30.9	54.9	54.9	97.6	97.6
17.6	---	31.2	---	55.6	---	98.8	---

RNR60 C 1003 F M

STYLE AND TERMINAL TYPE: The three-letter symbol identifies established reliability, film, fixed resistors of a specified terminal type; the two-digit number identifies the size and configuration. (See 3.4.)

CHARACTERISTIC: The single-letter symbol identifies the characteristic (as specified in table 302-I) as follows:

1/ C - - - ±50 ppm/°C; 125°C max ambient temperature at rated wattage
H - - - ±50 ppm/°C; 125°C max ambient temperature at rated wattage
1/ E - - - ±25 ppm/°C; 125°C max ambient temperature at rated wattage
J - - - ±25 ppm/°C; 125°C max ambient temperature at rated wattage
K - - - ±100 ppm/°C; 125°C max ambient temperature at rated wattage

RESISTANCE: The four-digit number identifies the nominal resistance value, expressed in ohms; the first three digits represent significant figures and the last digit specifies the number of zeros to follow.
* For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

10R0- - - - - 10 ohms
1001- - - - - 1,000 ohms
1003- - - - - 100,000 ohms

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

B - - - ±0.1 percent (not available in chrst. K)
D - - - ±0.5 percent (available in all chrst.)
F - - - ±1.0 percent (available in all chrst.)

LIFE FAILURE RATE DESIGNATION: The single-letter symbol identifies the life failure rate as follows:

M - - - - - - 1.0 percent/1,000 hr
P - - - - - - 0.1 percent/1,000 hr
R - - - - - - 0.01 percent/1,000 hr
S - - - - - - 0.001 percent/1,000 hr

1/ Hermetically sealed.

FIGURE 302-2. Type designation example for styles RNR50 through RNR70.

RNC90 Y 162R00 B M

STYLE AND TERMINAL TYPE: The three-letter symbol identifies established reliability, film, fixed resistors of a specified terminal type; the two-digit number identifies the size and configuration. (See 3.4.)

CHARACTERISTIC: The single-letter symbol identifies the characteristic (as specified in table 302-I) as follows:

Y - - - ±5 ppm/°C; 125°C max ambient temperature at rated wattage

RESISTANCE: Six characters identify the nominal resistance value, expressed in ohms -- five digits, all significant, and a single letter. The letter is used simultaneously as a decimal point and a multiplier. For values less than 1,000 ohms, the letter "R" represents the decimal point. For values 1,000 ohms or greater but less than 1 megohm, the letter "K" represents the decimal point. For values 1 megohm or greater, the letter "M" represents the decimal point. (See the following example.)

EXAMPLE:

50R500- - - - - 50.5 ohms
50K500- - - - - 50,500 ohms
5M0500- - - - - 5,050,000 ohms

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

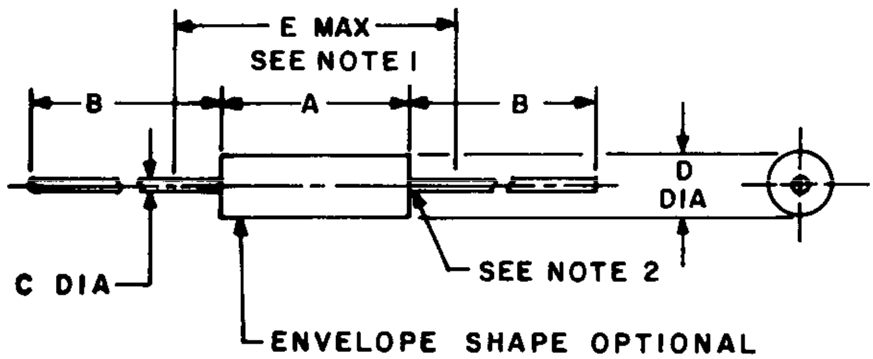
V - - - ±.005 percent resistance tolerance
T - - - ±.01 percent resistance tolerance
A - - - ±.05 percent resistance tolerance
B - - - ±0.1 percent resistance tolerance
D - - - ±0.5 percent resistance tolerance
F - - - ±1.0 percent resistance tolerance

LIFE FAILURE RATE DESIGNATION: The single-letter symbol identifies the life failure rate as follows:

M - - - - - 1.0 percent/1,000 hr
P - - - - - 0.1 percent/1,000 hr
R - - - - - 0.01 percent/1,000 hr
S - - - - - 0.001 percent/1,000 hr

FIGURE 302-3. Type designation example for style RNC90.

STYLES RNR50, RNR55, RNR60, RNR65, RNR70, RNR75



Standard styles*	Dimensions (inches)				
	A	B 1/	C ±.002	D	E Max.
* RNR50 2/	.150 ±.020	1.250 ±.266	.016	.065 ±.015	.225
* RNR55	.250 +.031 -.046	1.500 ±.125	.025	.109 ±.031	.379
RNR60	.375 ±.062	1.500 ±.125	.025	.125 +.040 -.031	.561
RNR65	.625 +.031 -.094	1.500 ±.125	.025	.188 +.062 -.031	.780
RNR70	.750 +.125 -.062	1.500 ±.125	.032	.250 +.078 -.031	.939
RNR75	1.062 ±.062	1.500 ±.125	.032	.375 +.062 -.031	1.186

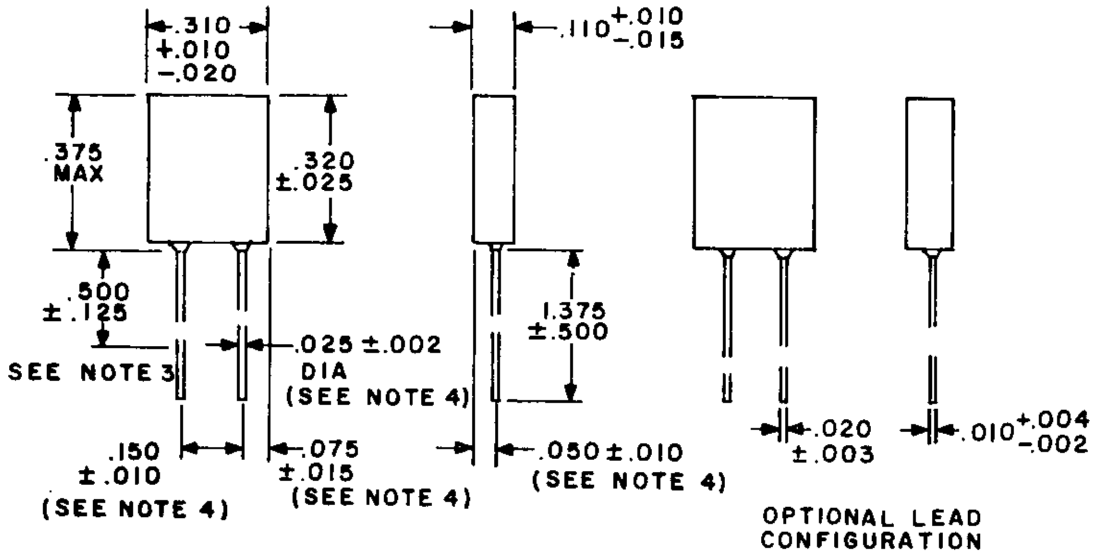
Inches	mm	Inches	mm
.002	.05	.180	4.57
.015	.38	.188	4.78
.016	.41	.225	5.72
.020	.51	.250	6.35
.025	.64	.266	6.76
.031	.79	.375	9.52
.032	.81	.379	9.63
.040	1.02	.561	14.25
.046	1.17	.625	15.88
.062	1.57	.750	19.05
.065	1.65	.780	19.81
.078	1.98	.939	23.85
.094	2.39	1.062	26.97
.109	2.77	1.186	30.12
.125	3.18	1.250	31.75
.150	3.81	1.500	38.10

1/ Lead length for tape and reel packaging shall be 1 inch minimum.
2/ For characteristics C, E, dimension A = .180 ±.020.
* Third letter is variable, dependent upon lead material or capability.

NOTES:
1. Maximum length is "clean lead" to "clean lead".
2. The end of the body is that point at which the body diameter equals the nearest drill size larger than 250 percent of the nominal lead diameter.

FIGURE 302-4. Established reliability, film, fixed resistors.

Style RNC90



Inches	mm	Inches	mm
.002	.05	.110	2.79
.010	.25	.125	3.18
.015	.38	.150	3.81
.020	.51	.310	7.87
.025	.64	.320	8.13
.050	1.27	.375	9.52
.075	1.91	.500	12.70
		1.375	34.92

NOTES:
1. Dimenisons are in inches.
2. Metric equivalents are given for general information only.
3. Resistance measurement point.
4. The lead measurement is made at the point of emergence from the body.

FIGURE 302-4. Established reliability, film, fixed resistors - Continued.

TABLE 302-I. Performance characteristics.

Features	C (Hermetically sealed)	H (Nonhermetically sealed)	E (Hermetically sealed)	J (Nonhermetically sealed)	K (Nonhermetically) sealed)	Y (Nonhermetically sealed)
Max resistance-temperature characteristic:						
Percent per degree C	±0.005	±0.005	±.0025	±0.0025	±0.01	±.0005
Parts per million/°C	±50	±50	±25	±25	±100	±5 1/
Max ambient temperature at rated wattage	125°C	125°C	125°C	125°C	125°C	125°C
Max ambient temperature at zero wattage derating	175°C	175°C	175°C	175°C	175°C	175°C
Power rating in watts and max dc or rms voltage at 125°C						
Style RNR50	1/20 W, 200 V	1/20 W, 200 V	1/20 W, 200 V	1/20 W, 200 V	1/20 W, 200 V	Not available
Style RNR55	1/10 W, 200 V	1/10 W, 200 V	1/10 W, 200 V	1/10 W, 200 V	1/10 W, 200 V	Not available
Style RNR60	1/8 W, 250 V	1/8 W, 250 V	1/8 W, 250 V	1/8 W, 250 V	1/8 W, 250 V	Not available
Style RNR65	1/4 W, 300 V	1/4 W, 300 V	1/4 W, 300 V	1/4 W, 300 V	1/4 W, 300 V	Not available
Style RNR70	1/2 W, 350 V	1/2 W, 350 V	1/2 W, 350 V	1/2 W, 350 V	1/2 W, 350 V	Not available
Style RNR75	Not available	Not available	1 W, 750 V	1 W, 750 V	Not available	Not available
Style RNC90	Not available	Not available	Not available	Not available	Not available	.3 W, 300 V
Power rating in watts and max dc or rms voltage at 70°C:						
Style RNR50	1/10 W, 200 V	1/10 W, 200 V	1/10 W, 200 V	1/10 W, 200 V	1/10 W, 200 V	Not available
Style RNR55	1/8 W, 200 V	1/8 W, 200 V	1/8 W, 200 V	1/8 W, 200 V	1/8 W, 200 V	Not available
Style RNR60	1/4 W, 300 V	1/4 W, 300 V	1/4 W, 300 V	1/4 W, 300 V	1/4 W, 300 V	Not available
Style RNR65	1/2 W, 350 V	1/2 W, 350 V	1/2 W, 350 V	1/2 W, 350 V	1/2 W, 350 V	Not available
Style RNR70	3/4 W, 500 V	3/4 W, 500 V	3/4 W, 500 V	3/4 W, 500 V	3/4 W, 500 V	Not available
Style RNR75	Not available	Not available	2 W, 750 V	2 W, 750 V	Not available	Not available
Style RNC90	Not available	Not available	Not available	Not available	Not available	.5 W, 300 V
Min and max resistance values: 2/	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max	Min / Max
Style RNR50	10.0 / .100 MΩ	49.9 / .796 MΩ	10.0 / .100 MΩ	49.9 / .796 MΩ	10.0 / .796 MΩ	Not available
Style RNR55	10.0 / 1.21 MΩ	10.0 / 2.0 MΩ	10.0 / 1.21 MΩ	10.0 / 2.0 MΩ	10.0 / 2.0 MΩ	Not available
Style RNR60	10.0 / 2.49 MΩ	2.0 3/ / 4.02 MΩ	10.0 / 2.49 MΩ	10.0 / 4.02 MΩ	1.0 3/ / 4.02 MΩ	Not available
Style RNR65	10.0 / 4.99 MΩ	1.0 3/ / 8.06 MΩ	10.0 / 4.99 MΩ	10.0 / 8.06 MΩ	1.0 3/ / 8.06 MΩ	Not available
Style RNR70	24.9 / 7.5 MΩ	1.0 3/ / 15 MΩ	24.9 / 7.5 MΩ	10.0 / 15 MΩ	1.0 3/ / 15 MΩ	Not available
Style RNR75	Not available	Not available	24.9 / 2.0 MΩ	49.9 / 5.0 MΩ	Not available	Not available
Style RNC90	Not available	Not available	Not available	Not available	Not available	4.99 kΩ / 100 kΩ
Max percent change in resistance values: 4/						
Temperature cycling Overload	0.2	0.2	0.2	0.2	0.2	0.05
Low temperature operation	0.15	0.15	0.15	0.15	0.15	0.05
Low temperature storage	0.15	0.15	0.15	0.15	0.15	0.05
Terminal strength	0.2	0.2	0.2	0.2	0.2	0.02
Dielectric withstanding voltage	0.15	0.15	0.15	0.15	0.15	0.02
Resistance to soldering heat	0.1	0.1	0.1	0.1	0.1	0.02
Moisture resistance	0.2	0.4	0.2	0.4	0.4	0.05
Shock (specified pulse)	0.2	0.2	0.2	0.2	0.2	0.01
Vibration, high frequency	0.2	0.2	0.2	0.2	0.2	0.02
Life	See 5/	See 5/	See 5/	See 5/	See 5/	See 5/
High temperature exposure	0.5	0.5	0.5	0.5	0.5	0.05
Insulation resistance (dry)	10,000 MΩ, min	10,000 MΩ, min	10,000 MΩ, min	10,000 MΩ, min	10,000 MΩ, min	10,000 MΩ, min
Insulation resistance (wet)	100 MΩ, min	100 MΩ, min	100 MΩ, min	100 MΩ, min	100 MΩ, min	100 MΩ, min
Resistance tolerance (± percent)	1.0, 0.5, 0.1	1.0, 0.5, 0.1	1.0, 0.5, 0.1, as applicable to style	1.0, 0.5, 0.1, as applicable to style	1.0, 0.5	1.0, 0.5, 0.1, 0.05, 0.01, 0.005

1/ Maximum resistance-temperature characteristic = ±5 ppm/°C (±.0005 percent per degree C) up to and including 125°C and ±10 ppm/°C (±.001 percent per degree C) from 125°C to 175°C.

2/ Resistance values are based on the .1 percent decade listed in this section. For other resistance tolerances, refer to 3.3.

3/ Minimum resistance is 10 ohms for B (.1 percent) tolerance.

4/ Where total resistance change is 1 percent or less, it shall be considered as ± (percent +0.01 ohm).

5/ The ΔR requirements shall be ±0.5 percent (qualification, 2,000 hr duration); ±2.0 percent (10,000 hr duration).

6/ The ΔR requirement shall be ±0.05 percent (qualification, 2,000 hr duration); ±0.5 percent (10,000 hr duration).

SECTION 303

RESISTORS, FIXED, WIREWOUND (ACCURATE), ESTABLISHED RELIABILITY

STYLES RBR52, RBR53, RBR54, RBR55, RBR56, RBR57, RBR71, AND RBR75

(APPLICABLE SPECIFICATION: MIL-R-39005)

1. SCOPE. This section covers established reliability, accurate, wirewound, fixed resistors that have a maximum initial resistance tolerance of 1.0 percent and a high degree of stability with respect to time under specified environmental conditions. These resistors provide life failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level (initial qualification) and maintained at a 10-percent producer's risk. The failure rate is referred to operation at full rated wattage and temperature with a maximum change in resistance of ±0.2 percent at 0 to 10,000 hours of life test. These resistors are not designed for high-frequency applications where ac performance is of critical importance. They are especially suited for use in dc amplifiers, voltmeter multipliers, electronic computers, meters, and laboratory test equipment.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. In these resistors, the resistance element consists of a precisely measured (by ohmic value) length of resistance wire, wound on a bobbin or core (usually of ceramic). The resistance wire is an alloy metal without joints, welds, or bonds (except for splicing at midpoint of a bifilar winding and at end terminals). In order to minimize inductance, resistors are wound by one of the following methods: reverse pi-winding or bifilar winding. The element assembly is then protected by a coating or enclosure of moisture-resistant insulating material which completely covers the exterior of the resistance element including connections and terminations. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of the processes and controls used in manufacturing these resistors.

2.1.2 Power rating. These resistors have a power rating based on operation at an ambient temperature of 125°C. If these resistors are to be operated at an ambient temperature greater than 125°C, the resistor should be derated in accordance with figure 303-1.

2.1.3 Resistance tolerance and wattage input. When using resistors with low resistance values and a tolerance of 0.1 percent or less, the design engineer must consider the fact that the resistance of the leads and other wires connected to the resistor may exceed the tolerance. Where a resistor is used in a critical application that requires the initial tolerance to be 0.1 percent or less, it is also desirable to hold resistance changes within this tolerance during operation. Since the temperature characteristic can cause the resistance to change by more than 0.1 percent, the temperature rise in the resistor must be kept to a minimum if the resistor is expected to remain within the initial tolerance during use. It is to be noted that initial nominal resistance is measured at 25°C while full-load operating temperature is 125°C. Therefore, if this close tolerance of 0.1 percent or less is to be held, the power rating of the resistors shall be reduced as indicated in table 303-I.

TABLE 303-I. Resistance tolerance and wattage input.

Symbol	Resistance tolerance	Permissible percent of normal wattage 1/
T - - - -	±.01%	50
A - - - -	±.05%	50
B - - - -	±0.1%	50
F - - - -	±1.0%	100

1/ These values represent the maximum wattage at which resistors should be operated at an ambient temperature up to 125°C.

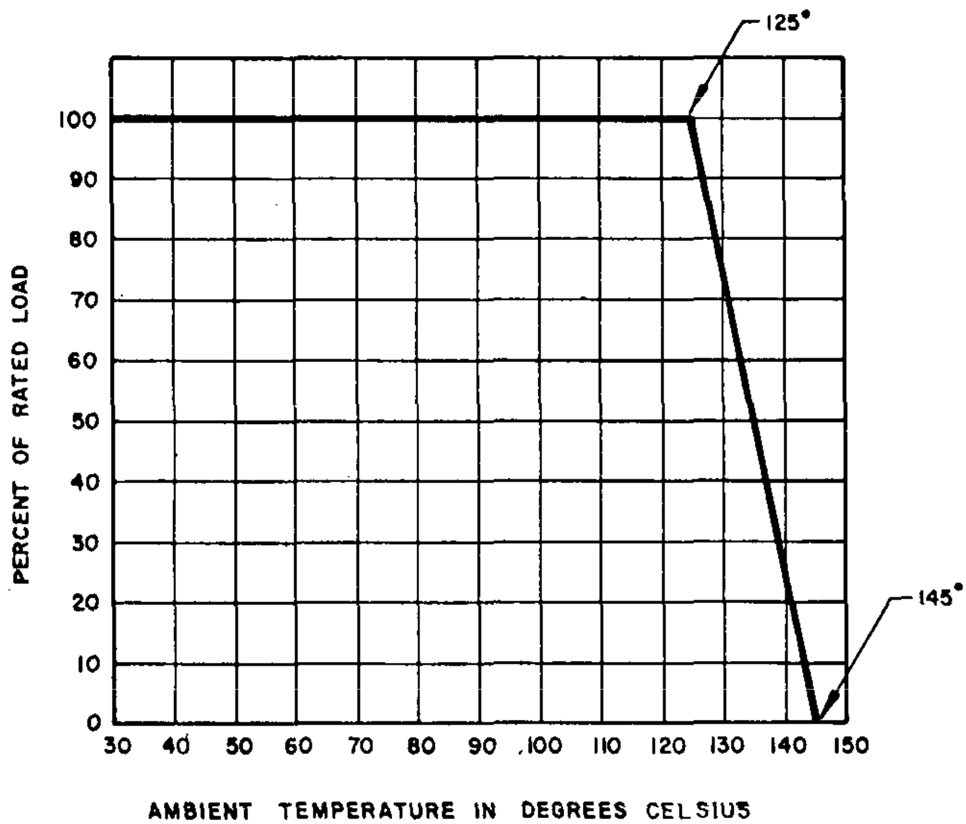


FIGURE 303-1. Derating curve for high ambient temperature.

2.1.4 Derating for optimum performance. Because all of the electrical energy dissipated by a resistor is converted into heat energy, the temperature of the surrounding air becomes an influencing factor in the selection of a particular resistor for use in a specific application. After the desired resistance tolerance and the anticipated maximum ambient temperature have been determined, a safety factor of 2, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential, and one which will remain within specified tolerance limits.

2.2 Supplementary insulation. Where high voltages (250 volts and higher) are present between the resistor circuit and the grounded surface on which the resistor is mounted, or where resistance is so high that the insulation resistance to ground is an important factor, secondary insulation between the resistor and its mounting, or between mounting and ground, should be provided.

2.3 Soldering. Care must be exercised in soldering these resistors, particularly in the lower resistance values and tighter tolerances, since high contact resistance might cause resistance changes greater than the tolerance.

2.4 Mounting. It is suggested that wire-lead-terminal resistors be mounted by restraining their bodies from movement when shock or high-frequency-vibration forces are to be encountered.

2.5 Recommended maximum ambient temperature. The maximum ambient temperature should not exceed 135°C for all styles.

2.6 Terminals. Weldable terminals ("U" terminals only) are type N-1 of MIL-STD-1276. Solderable terminals ("L" terminals only) have met the criteria for wire lead terminal evaluation in test method 208 of MIL-STD-202.

2.7 Maximum weight. The maximum weight of each style is as follows:

RBR52	6.0 grams
RBR53	5.0 grams
RBR54	2.5 grams
RBR55	2.0 grams
RBR56	1.5 grams
RBR57	10.0 grams
RBR71	1.5 grams
RBR75	1.5 grams

2.8 Screening requirements. All resistors furnished under MIL-R-39005 are subjected to a 100-hour conditioning life test by cycling at rated wattage at 125°C followed by a total resistance measurement check and a visual examination for evidence of mechanical damage.

2.9 Resistive element wire size. Use of wire size of less than .001 inch diameter is not recommended for new design.

2.10 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Falure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±.2 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

3. ITEM IDENTIFICATION (see figures 303-2 and 303-3).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 303-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 303-II.

3.3 Resistance values. Resistance values for tolerances B (.1 percent), A (.05 percent), Q (.02 percent), and T (.01 percent) may be any value, but it is preferred that the values be chosen from the A or B tolerance values. Resistance values for the F (1.0 percent) tolerance shall follow the following tabulation:

Resistance values for the 10 to 100 decade

A (.05) B (.1)	F (1.0)	A (.05) B (.1)	F (1.0)	A (.05) B (.1)	F (1.0)	A (.05) B (.1)	F (1.0)
10.0	10.0	17.8	17.8	31.6	31.6	56.2	56.2
10.1	---	18.0	---	32.0	---	56.9	---
10.2	10.2	18.2	18.2	32.4	32.4	57.6	57.6
10.4	---	18.4	---	32.8	---	58.3	---
10.5	10.5	18.7	18.7	33.2	33.2	59.0	59.0
10.6	---	18.9	---	33.6	---	59.7	---
10.7	10.7	19.1	19.1	34.0	34.0	60.4	60.4
10.9	---	19.3	---	34.4	---	61.2	---
11.0	11.0	19.6	19.6	34.8	34.8	61.9	61.9
11.1	---	19.8	---	35.2	---	62.6	---
11.3	11.3	20.0	20.0	35.7	35.7	63.4	63.4
11.4	---	20.3	---	36.1	---	64.2	---
11.5	11.5	20.5	20.5	36.5	36.5	64.9	64.9
11.7	---	20.8	---	37.0	---	65.7	---
11.8	11.8	21.0	21.0	37.4	37.4	66.5	66.5
12.0	---	21.3	---	37.9	---	67.3	---
12.1	12.1	21.5	21.5	38.3	38.3	68.1	68.1
12.3	---	21.8	---	38.8	---	69.0	---
12.4	12.4	22.1	22.1	39.2	39.2	69.8	69.8
12.6	---	22.3	---	39.7	---	70.6	---
12.7	12.7	22.6	22.6	40.2	40.2	71.5	71.5
12.9	---	22.9	---	40.7	---	72.3	---
13.0	13.0	23.2	23.2	41.2	41.2	73.2	73.2
13.2	---	23.4	---	41.7	---	74.1	---
13.3	13.3	23.7	23.7	42.2	42.2	75.0	75.0
13.5	---	24.0	---	42.7	---	75.9	---
13.7	13.7	24.3	24.3	43.2	43.2	76.8	76.8
13.8	---	24.6	---	43.7	---	77.7	---
14.0	14.0	24.9	24.9	44.2	44.2	78.7	78.7
14.2	---	25.2	---	44.8	---	79.6	---
14.3	14.3	25.5	25.5	45.3	45.3	80.6	80.6
14.5	---	25.8	---	45.9	---	81.6	---
14.7	14.7	26.1	26.1	46.4	46.4	82.5	82.5
14.9	---	26.4	---	47.0	---	83.5	---
15.0	15.0	26.7	26.7	47.5	47.5	84.5	84.5
15.2	---	27.1	---	48.1	---	85.6	---
15.4	15.4	27.4	27.4	48.7	48.7	86.6	86.6
15.6	---	27.7	---	49.3	---	87.6	---
15.8	15.8	28.0	28.0	49.9	49.9	88.7	88.7
16.0	---	28.4	---	50.5	---	89.8	---
16.2	16.2	28.7	28.7	51.1	51.1	90.9	90.9
16.4	---	29.1	---	51.7	---	92.0	---
16.5	16.5	29.4	29.4	52.3	52.3	93.1	93.1
16.7	---	29.8	---	53.0	---	94.2	---
16.9	16.9	30.1	30.1	53.6	53.6	95.3	95.3
17.2	---	30.5	---	54.2	---	96.5	---
17.4	17.4	30.9	30.9	54.9	54.9	97.6	97.6
17.6	---	31.2	---	55.6	---	98.8	---

RBR52 L 50R50 A M

STYLE: The three-letter symbol "RBR" identifies accurate, wirewound, fixed resistors; the two-digit number identifies the size and power rating.

TERMINAL AND ΔR PERFORMANCE REQUIREMENT: The single letter symbol identifies the terminal and ΔR requirement as follows:

L - - - - - - - - Solderable (tightened ΔR)
U - - - - - - - - Weldable (tightened ΔR)

RESISTANCE: 1/ The five-digit number identifies the nominal resistance value, expressed in ohms; the first four digits represent significant figures and the last digit specifies the number of zeros to follow. * For values less than 1,000 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

R1000 - - - - - - - 0.100 ohms
10R00 - - - - - - - 10.0 ohms
10000 - - - - - - - 1000 ohms
10002 - - - - - - - 0.1 megohm

INITIAL RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance (25 ±2°C) as follows:

T - - - - - - - - - - ±.01 percent
A - - - - - - - - - - ±.05 percent
B - - - - - - - - - - ±.1 percent
F - - - - - - - - - - ±1.0 percent

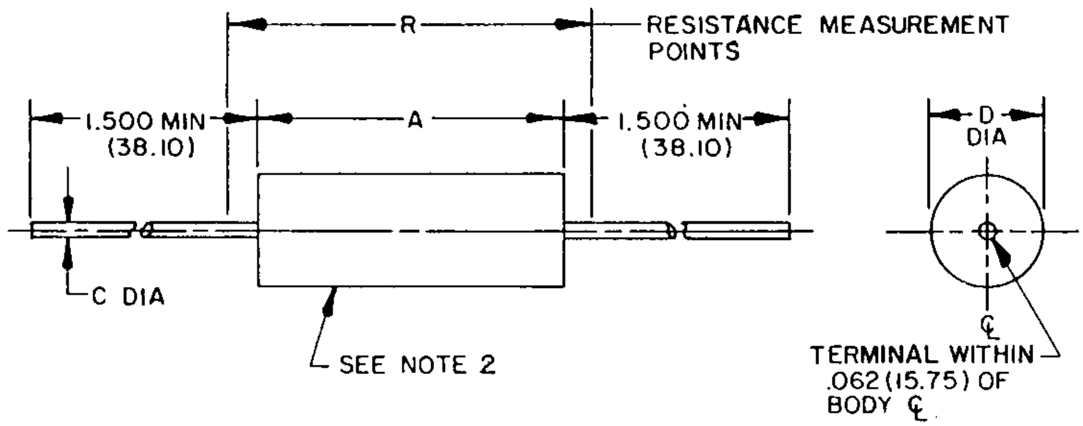
LIFE FAILURE RATE: The single-letter symbol identifies the life failure rate as follows:

M - - - - - 1.0 percent/1,000 hr
P - - - - - 0.1 percent/1,000 hr
R - - - - - 0.01 percent/1,000 hr

*
1/ When a nondecade resistance value is required, the actual resistance value is used.

FIGURE 303-2. Type designation example.

STYLES RBR52, RBR53, RBR54, RBR55, RBR56, RBR57, AND RBR75



Standard style	Dimensions			
	A +.020 (.51) -.032 (.81)	R ±.030 (.76)	C ±.002(.05)	D ±.015 (.38)
RBR52	1.000 (25.40)	1.250 (31.75)	.032 (.81)	.375 (9.53)
RBR53	.750 (19.05)	1.250 (31.75)	.032 (.81)	.375 (9.53)
RBR54	.750 (19.05)	1.250 (31.75)	.032 (.81)	.250 (6.35)
RBR55	.500 (12.70)	1.250 (31.75)	.032 (.81)	.250 (6.35)
RBR56	.344 (8.74)	.625 (15.88)	.032 (.81)	.250 (6.35)
RBR57	1.000 (25.40)	1.750 (44.45)	.032 (.81)	.500 (12.70)
RBR75	.295 (7.49)	.687 (17.45)	.025 (.64)	.250 (6.35)

NOTES:

1. Envelope-essentially cylindrical, no square or rectangular sections.
2. Dimension A is "clean lead" to "clean lead".

STYLE RBR71

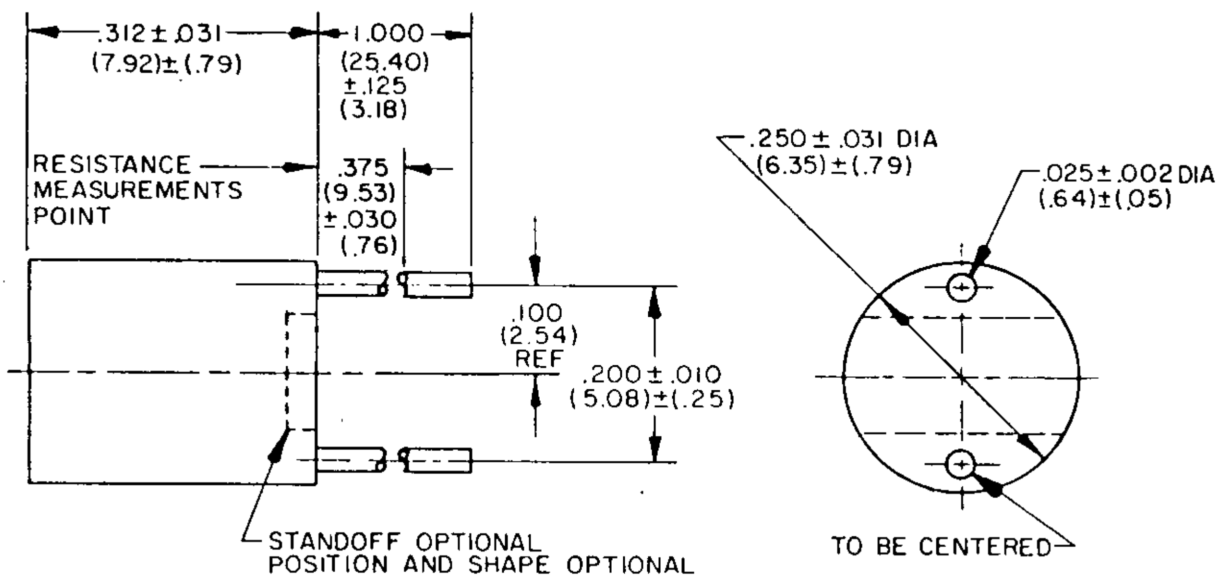


FIGURE 303-3. Establish reliability, wirewound (accurate), fixed resistors.

TABLE 303-II. Performance requirements

Features		RBR52	RBR53	RBR54	RBR55	RBR56	RBR57	RBR71	RBR75
Maximum resistance temperature characteristic in ppm/°C (Ref to 25°C)	Less than 1 ohm - - - -	±90	±90	±90	±90	±90	±90	±90	±90
	1 to less than 10 ohms-	±30	±30	±30	±30	±30	±30	±30	±30
	10 to less than 100 ohms	±15	±15	±15	±15	±15	±15	±15	±15
	100 ohms and above- - -	±10	±10	±10	±10	±10	±10	±10	±10
Maximum ambient temperature at rated wattage - - - -		125°C	125°C	125°C	125°C	125°C	125°C	125°C	125°C
Maximum ambient temperature at zero wattage derating		145°C	145°C	145°C	145°C	145°C	145°C	145°C	145°C
Power rating in watts and maximum dc or rms voltage - - - - - - - - - - - - - -		1/2 watt 600 volts	1/3 watt 300 volts	1/4 watt 300 volts	.15 watt 200 volts	1/8 watt 150 volts	3/4 watt 600 volts	1/8 watt 150 volts	1/8 watt 150 volts
Minimum resistance value (ohms):									
Resistance tolerance F - - - - - - - - - - - - - - - -		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Resistance tolerance T,A,B - - - - - - - - - - - - -		10	10	10	10	10	10	10	10
Maximum resistance (.001" dia wire) (megohms):									
Resistance tolerance T, A - - - - - - - - - - - - - -		.806	.499	.255	.150	.100	1.37	.100	.0715
Resistance tolerance B - - - - - - - - - - - - - - -		.806	.499	.255	.150	.100	1.37	.100	.0715
Resistance tolerance F - - - - - - - - - - - - - - -		.806	.499	.255	.150	.100	1.37	.100	.0715
Insulation resistance (megohms):									
Dry -		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Wet -		100	100	100	100	100	100	100	100
Terminal and ΔR requirement- - - - - - - - - - - - -		L and U	L and U	L and U	L and U	L and U	L and U	L and U	L and U
Maximum percent change in resistance (±): 1/									
Conditioning- - - - - - - - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Short-time overload - - - - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Temperature cycling - - - - - - - - - - - - - - - -		.05	.05	.05	.05	.05	.05	.05	.05
Salt-water-immersion cycling- - - - - - - - - - - -		.1	.1	.1	.1	.1	.1	.4	.1
Dielectric-withstanding voltage - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Terminal strength - - - - - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Moisture resistance - - - - - - - - - - - - - - - -		.1	.1	.1	.1	.1	.1	.4	.1
Shock (specified pulse) - - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Resistance to soldering heat- - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Vibration, high frequency - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Low-temperature storage - - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Low-temperature operation - - - - - - - - - - - - -		.01	.01	.01	.01	.01	.01	.01	.01
Life:									
Initial qualification (2,000 hr) - - - - - - - - -		.1	.1	.1	.1	.1	.1	.1	.1
Failure rate determination (10,000 hr) - - - - - -		.2	.2	.2	.2	.2	.2	.2	.2
High-temperature exposure - - - - - - - - - - - - -		.1	.1	.1	.1	.1	.1	.1	.1
Resistance tolerance (± percent) - - - - - - - - - -		.01, .05, .1, 1	.01, .05, .1, 1	.01, .05, .1, 1	.01, .05, .1, 1	.01, .05, .1, 1	.01, .05, .1, 1	.01, .05, .1, 1	.01, .05, .1, 1

1/ Where resistance is less than 10 ohms, it shall be considered as ±(__ percent +0.1 ohm).

SECTION 304

RESISTORS, FIXED, WIREWOUND (POWER TYPE), ESTABLISHED RELIABILITY

STYLES RWR78, RWR80, RWR81, RWR82, RWR84, AND RWR89

(APPLICABLE SPECIFICATION: MIL-R-39007)

1. SCOPE. This section covers established reliability, power type, wirewound, fixed resistors, having axial leads. These resistors have a maximum initial resistance tolerance of ±1.0 percent. These resistors provide failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level (initial qualification) and maintained at a 10-percent manufacturer's risk. The failure rate is referred to operation at full rated wattage and temperature with a maximum change in resistance of ±1.0 percent at 0 to 10,000 hours of life test.

2. APPLICATION INFORMATION.

2.1 Construction. The construction of these resistors employs a measured length of resistance wire or ribbon (of a known ohmic value) wound in a precise manner (pitch, effective wire coverage, and wire diameter are specification controlled). The continuous length of wire (wire required to be free of joints, bond, and of uniform cross-section) is wound on a ceramic core or tube and attached to end terminations. The element is then coated or enclosed by inorganic vitreous or a silicone coating to protect it from moisture or other detrimental environmental conditions. Due to the reliability requirements of MIL-R-39007, processes and controls utilized in manufacturing are necessarily more stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of these requirements. Resistors of this section have an added requirement for noninductive type winding. Resistors which are identified by the terminal and winding designator "N" or "Z" are noninductively wound by the Ayrton-Perry method.

2.2 Derating at high temperature. The power rating is based on operation at 25°C; however, when a resistor is to be used in a circuit where the surrounding temperature is higher than 25°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the curve shown on figure 304-1.

2.3 Derating for optimum performance. Because all of the electrical energy dissipated by a resistor is converted into heat energy, the temperature of the surrounding air becomes an influencing factor in the selection of a particular resistor for use in a specific application. The power rating for these resistors is based on operation at an ambient temperature of 25°C; however, in actual use, the resistors may not be operating at this temperature. After the desired resistance tolerance and the anticipated maximum ambient temperature have been determined, a safety factor of 2, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential, and one which will remain within specified tolerance limits.

2.4 Choice of style. Resistors to be used in equipment should be so chosen that, when mounted in the equipment, they will not be required to operate at a temperature in excess of their rating. This should be applicable under the most severe conditions, as follows:

a. In the maximum specified ambient temperature.
b. Under conditions producing maximum temperature rise in each resistor.
c. For a sufficient length of time to produce maximum temperature rise, or for the maximum specified time.
d. With all enclosure in place.
e. With natural ventilation only. (This should permit the use of any special ventilating provisions included as a standard part of the equipment.)
f. At high altitude.

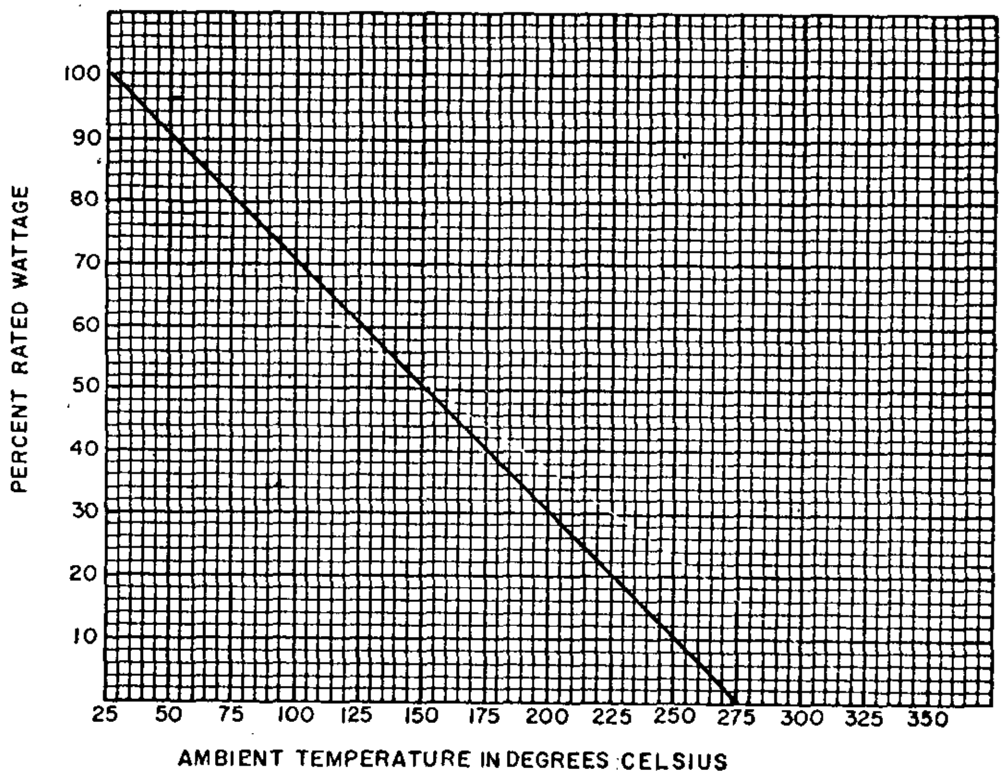


FIGURE 304-1. Derating curve for high ambient temperature.

2.5 Spacing. When resistors are mounted in rows or banks, they should be so spaced that, taking into consideration the restricted ventilation and heat dissipation by nearby resistors, no resistor in the rows or banks exceeds its maximum permissible hot-spot temperature. An appropriate combination of resistor spacing and resistor power rating must be chosen if this is to be insured.

2.6 Soldering. A solder with a minimum melting temperature of 350°C should be used for soldering. Care must be exercised in soldering low value and tighter tolerance resistors since high contact resistance may cause resistance changes exceeding the tolerance.

2.7 Mounting. Under conditions of severe shock or vibration, or a combination of both, resistors of all sizes described in this section should be mounted in such a fashion that the body of the resistor is restrained from movement with respect to the mounting base. It should be noted that if clamps are used, certain electrical characteristics of the resistor will be altered. The heat-dissipating qualities of the resistor will be enhanced or retarded depending on whether the clamping material is a good or poor heat conductor. Under less severe vibration conditions, axial lead styles may be supported by their leads only. The lead lengths should be kept as short as possible, 1/4 inch or less preferred, but no longer than 5/8 inch. The longer the lead, the more likely that a mechanical failure will occur.

2.8 Secondary insulation. Where high voltages are present between resistor circuits and grounded surfaces on which resistors are mounted, secondary insulation capable of withstanding the voltage conditions should be provided between resistors and mountings or between mountings and ground.

2.9 Failure rate factors. Failures are considered to be open, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance.

Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±1.0 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

2.10 Maximum weight. Maximum weight of each style is as follows:

Style	S and W terminal and winding	N and Z terminal and winding
RWR78- - - - - - - -	12 grams	13 grams
RWR80- - - - - - - -	1 gram	1 gram
RWR81- - - - - - - -	.35 gram	.70 gram
RWR82- - - - - - - -	.3 gram	---
RWR84- - - - - - - -	5 grams	6 grams
RWR89- - - - - - - -	3 grams	4 grams

2.11 Screening. All resistors furnished under MIL-R-39007 are subjected to a conditioning 100-hour life test by cycling at full load at 25°C. This shall be followed by a total resistance measurement and a visual examination for mechanical damage.

2.12 Coating materials. Certain coating materials used in fabricating resistors furnished under MIL-R-39007 may be subject to "outgassing" of volatile material when operated at surface temperatures over 200°C. This phenomena should be taken into consideration for equipment design.

2.13 Reactance (applicable to "N" and "Z" terminals and windings only). When resistors are tested under MIL-R-39007, they shall be within the maximum limits specified as follows:

	Maximum effective series inductance - µH		Maximum effective parallel capacitance - pF
Styles 1/	50Ω and below	Above 50Ω	All resistance values
RWR78	0.65	1.20	1.5
RWR80	0.20	0.37	1.5
RWR81	0.20	0.37	1.5
RWR84	0.30	0.60	1.5
RWR89	0.20	0.37	1.5

1/ Not applicable to style RWR82.

3. ITEM IDENTIFICATION (see figures 304-2 and 304-3).

3.1 Type designation. Type designation is used for identifying and describing the resistor as shown on figure 304-2.

3.2 Performance characteristics. Performance characteristics are shown in table 304-I.

3.3 Resistance values. Resistance values for tolerance B (0.1 percent) may be any value, but it is preferred that the values be chosen from the D tolerance values. Resistance values for the F (1.0 percent) and D (0.5 percent) tolerances shall follow the following tabulation:

Resistance tolerance.

D (.05)	F (1.0)	D (.05)	F (1.0)	D (.05)	F (1.0)	D (.05)	F (1.0)
10.0	10.0	17.8	17.8	31.6	31.6	56.2	56.2
10.1	---	18.0	---	32.0	---	56.9	---
10.2	10.2	18.2	18.2	32.4	32.4	57.6	57.6
10.4	---	18.4	---	32.8	---	58.3	---
10.5	10.5	18.7	18.7	33.2	33.2	59.0	59.0
10.6	---	18.9	---	33.6	---	59.7	---
10.7	10.7	19.1	19.1	34.0	34.0	60.4	60.4
10.9	---	19.3	---	34.4	---	61.2	---
11.0	11.0	19.6	19.6	34.8	34.8	61.9	61.9
11.1	---	19.8	---	35.2	---	62.6	---
11.3	11.3	20.0	20.0	35.7	35.7	63.4	63.4
11.4	---	20.3	---	36.1	---	64.2	---
11.5	11.5	20.5	20.5	36.5	36.5	64.9	64.9
11.7	---	20.8	---	37.0	---	65.7	---
11.8	11.8	21.0	21.0	37.4	37.4	66.5	66.5
12.0	---	21.3	---	37.9	---	67.3	---
12.1	12.1	21.5	21.5	38.3	38.3	68.1	68.1
12.3	---	21.8	---	38.8	---	69.0	---
12.4	12.4	22.1	22.1	39.2	39.2	69.8	69.8
12.6	---	22.3	---	39.7	---	70.6	---
12.7	12.7	22.6	22.6	40.2	40.2	71.5	71.5
12.9	---	22.9	---	40.7	---	72.3	---
13.0	13.0	23.2	23.2	41.2	41.2	73.2	73.2
13.2	---	23.4	---	41.7	---	74.1	---
13.3	13.3	23.7	23.7	42.2	42.2	75.0	75.0
13.5	---	24.0	---	42.7	---	75.9	---
13.7	13.7	24.3	24.3	43.2	43.2	76.8	76.8
13.8	---	24.6	---	43.7	---	77.7	---
14.0	14.0	24.9	24.9	44.2	44.2	78.7	78.7
14.2	---	25.2	---	44.8	---	79.6	---
14.3	14.3	25.5	25.5	45.3	45.3	80.6	80.6
14.5	---	25.8	---	45.9	---	81.6	---
14.7	14.7	26.1	26.1	46.4	46.4	82.5	82.5
14.9	---	26.4	---	47.0	---	83.5	---
15.0	15.0	26.7	26.7	47.5	47.5	84.5	84.5
15.2	---	27.1	---	48.1	---	85.6	---
15.4	15.4	27.4	27.4	48.7	48.7	86.6	86.6
15.6	---	27.7	---	49.3	---	87.6	---
15.8	15.8	28.0	28.0	49.9	49.9	88.7	88.7
16.0	---	28.4	---	50.5	---	89.8	---
16.2	16.2	28.7	28.7	51.1	51.1	90.9	90.9
16.4	---	29.1	---	51.7	---	92.0	---
16.5	16.5	29.4	29.4	52.3	52.3	93.1	93.1
16.7	---	29.8	---	53.0	---	94.2	---
16.9	16.9	30.1	30.1	53.6	53.6	95.3	95.3
17.2	---	30.5	---	54.2	---	96.5	---
17.4	17.4	30.9	30.9	54.9	54.9	97.6	97.6
17.6	---	31.2	---	55.6	---	98.8	---

RWR78 S 1R00 F M

STYLE: The three-letter symbol "RWR" identifies established reliability, axial-lead, power type, wirewound fixed resistors; the number identifies the size, wattage rating, and construction of the resistors.

TERMINAL AND WINDING: The single-letter symbol identifies the terminal and inductive or noninductive winding as follows:

- S- - - - - -Solderable
- W- - - - - -Weldable
- N- - - - - -Solderable, noninductively wound
- Z- - - - - -Weldable, noninductively wound

RESISTANCE: The four-digit number identifies the nominal resistance value, expressed in ohms; the first three digits represent significant figures *and the last digit specifies the number of zeros* to follow. For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.) *

EXAMPLE:

1R00- - - - -	1 ohm
10R0- - - - -	10 ohms
1000- - - - -	100 ohms
1001- - - - -	1,000 ohms
1002- - - - -	10,000 ohms

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

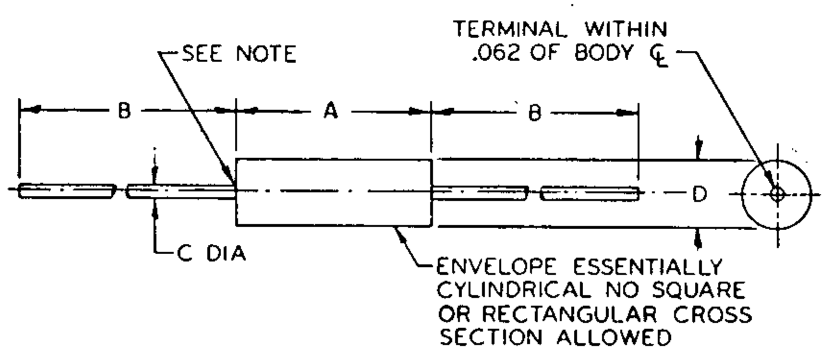
B - - - - - -	±0.1 percent
D - - - - - -	±0.5 percent
F - - - - - -	±1.0 percent

FAILURE RATE: The single-letter symbol identifies the failure rate as follows:

M - - - - - -	1.0 percent/1,000 hr
P - - - - - -	0.1 percent/1,000 hr
R - - - - - -	0.01 percent/1,000 hr
S - - - - - -	0.001 percent/1,000 hr

FIGURE 304-2. Type designation example.

STYLES RWR78, RWR80, RWR81, RWR82, RWR84, AND RWR89



Dimensions (inches)				
Style	A	B, Min	C	D
RWR78	1.780±.062 (45.21±1.57)	1.500 (38.10)	.040 ±.002 (1.02±.05)	.375±.031 (9.53±.79)
RWR80	.406±.031 (10.31± .79)	1.500 (38.10)	.0200±.0015 (.51±.04)	.094±.031 (2.39±.79)
RWR81	.250±.031 (6.35± .79)	1.500 (38.10)	.0200±.0015 (.51±.04)	.085±.020 (2.16±.51)
RWR82	.312±.016 (7.92± .41)	1.500 (38.10)	.020 ±.002 (.51±.05)	.078±.016 (1.98±.41)
RWR84	.875±.062 (22.23±1.57)	1.500 (38.10)	.040 ±.002 (1.02±.05)	.312±.031 (7.92±.79)
RWR89	.560±.062 (14.22±1.57)	1.500 (38.10)	.032 ±.002 (.81±.05)	.187±.031 (4.75±.79)

NOTE: Dimension A is "clean lead" to "clean lead".

FIGURE 304-3. Established reliability, power type, wirewound, fixed resistors.

TABLE 304-I. Performance characteristics.

Features		RWR78	RWR80	RWR81	RWR82 1/	RWR84	RWR89
Max resistance-temperature characteristic in ppm/°C (Ref to 25°C)	.1 to .499 ohm	+650	+650	+650	+650	+650	+650
	.499 to 1 ohms	+400	+400	+400	+400	+400	+400
	1 ohm to below 10 ohms	±50	±50	±50	±50	±50	±50
	10 ohms and above	±20	±20	±20	±20	±20	±20
Min resistance (ohm) 2/		0.1	0.1	0.1	0.1	0.1	0.1
Min resistance (ohms) (noninductive "N" and "Z" types) 3/		10	10	10	---	10	10
Max resistance 0.00175 inch or larger dia wire (K ohm)		6.98	.357	.2	.931	2.94	.931
* Max resistance 0.008 inch nominal dia wire (K ohm)		39.2	3.16	1.0	1.3	12.4	4.12
Max resistance (noninductive "N" and "Z" types)(.001 dia wire)		19.6	.604	.232	---	6.19	1.78
Power rating (watts)		10	2	1	1.5	7	3
Max ambient temperature at rated wattage (°C)		25	25	25	25	25	25
Max ambient temperature at zero wattage derating (°C)		275	275	275	275	275	275
Max percent change in resistance: 4/							
Conditioning		0.2	0.2	0.2	0.2	0.2	0.2
Temperature cycling		0.2	0.2	0.2	0.2	0.2	0.2
Short-time overload		0.2	0.2	0.2	0.2	0.2	0.2
Dielectric withstanding voltage		0.1	0.1	0.1	0.1	0.1	0.1
Moisture resistance		0.2	0.2	0.2	0.2	0.2	0.2
Terminal strength		0.1	0.1	0.1	0.1	0.1	0.1
Shock (specified pulse)		0.1	0.1	0.1	0.1	0.1	0.1
Vibration, high frequency		0.1	0.1	0.1	0.1	0.1	0.1
Life:							
Qualification (2,000 hr)		0.5	0.5	0.5	0.5	0.5	0.5
Failure rate determination (10,000 hr)		1.0	1.0	1.0	1.0	1.0	1.0
High temperature exposure		0.5	0.5	0.5	0.5	0.5	0.5
Low temperature storage		0.1	0.1	0.1	0.1	0.1	0.1
Min insulation resistance (megohms)							
Dry (initial)		1,000	1,000	1,000	1,000	1,000	1,000
Wet (after moisture resistance)		100	100	100	100	100	100

1/ Not available with noninductive winding ("N" and "Z" types).
2/ For resistance tolerance B (.1 percent), minimum resistance is .499 ohm.
3/ Resistance values below 10 ohms do not require noninductive windings. Inductively wound resistors at these low values exhibit reactances well within the limits established for noninductively wound resistors.
4/ Where total resistance change is 1 percent or less, it shall be considered as ±(_percent +0.05 ohm).

SECTION 305

RESISTORS, FIXED, FILM (INSULATED), ESTABLISHED RELIABILITY

STYLES RLR05, RLR07, RLR20, AND RLR32

(APPLICABLE SPECIFICATION: MIL-R-39017)

1. SCOPE. This section covers established reliability, insulated, film, fixed resistors, having film-type resistance element and axial leads. These resistors have resistance tolerances of ±1.0 and ±2.0 percent. These resistors provide life failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level (initial qualification) and maintained at a 10-percent producer's risk. The failure rate is referred to operation at full rated wattage and temperature (70°C) with a maximum change in resistance of ±4.0 percent at 0 to 10,000 hours of life test. These resistor styles are used in applications requiring better stability, tolerance, and temperature coefficient requirements than carbon composition types. For applications requiring greater precision and tighter tolerances, the use of metal film or wirewound resistors is indicated.

2. APPLICATION INFORMATION.

2.1 Construction. In these resistors, the resistance element consists of a film-type resistance element (tin oxide, metal glaze, etc.,) which has been formed on a substrate by one of several processes depending upon the manufacturer. The element is spiraled to achieve ranges in resistance value and, after lead attachment, the element is coated to protect it from moisture or other detrimental environmental conditions. Due to the reliability requirements of MIL-R-39017, processes and controls utilized in manufacturing are necessarily more stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of these requirements.

2.2 Derating at high temperature. The power rating is based on full-load operation at an ambient temperature of 70°C. However, when a resistor is to be used in a circuit where the surrounding temperature is higher than 70°C, a correction factor should be applied to the wattage rating so as not to overload the resistor. This correction factor may be taken from the curve shown on figure 305-1.

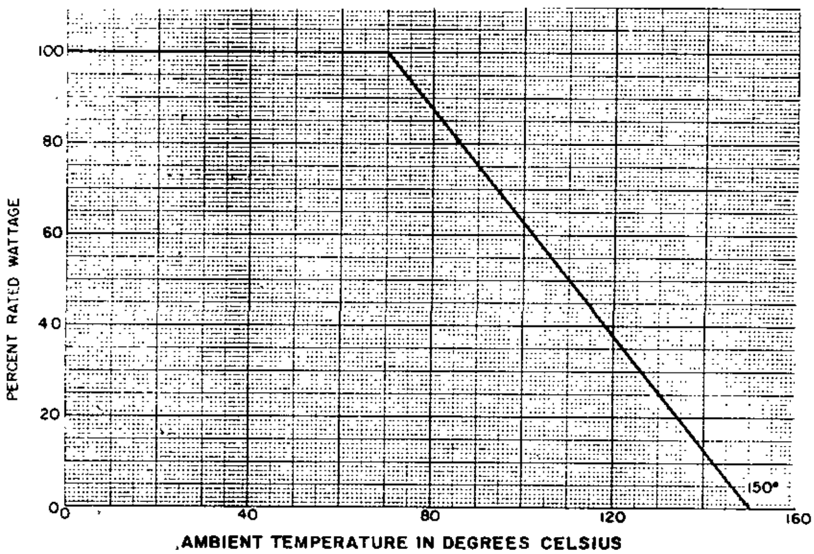


FIGURE 305-1. Derating curve for high ambient temperature.

2.3 Derating for optimum performance. After the maximum ambient temperature has been determined, a safety factor of two applied to the wattage is recommended in order to insure the selection of a resistor with an adequate wattage dissipation potential.

2.4 Resistance tolerance. Designers should bear in mind that operation of these resistors under the ambient conditions for which military equipment is designed may cause permanent or temporary changes in resistance sufficient to exceed their initial tolerance. In particular, operation at extreme temperatures may cause relatively large temporary changes in resistance.

2.5 Maximum voltage. The maximum continuous working voltage specified for each style should in no case be exceeded, regardless of the theoretically calculated rated voltage.

2.6 Noise. Noise output is uncontrolled by the specification but is considered a negligible quantity.

2.7 Shelf life. MIL-R-39017 estimates a change of resistance of .2 percent (average) per year under normal storage conditions (25° ±10°C) with relative humidity not exceeding 90 percent.

2.8 Maximum weight. The maximum weight for each style is as follows:

RLR05 - - - - - - - - -	.30 gram
RLR07 - - - - - - - - -	.50 gram
RLR20 - - - - - - - - -	.75 gram
RLR32 - - - - - - - - -	1.50 grams

2.9 Frequency characteristics. These resistors are virtually noninductive. A typical response curve is illustrated on figure 305-2.

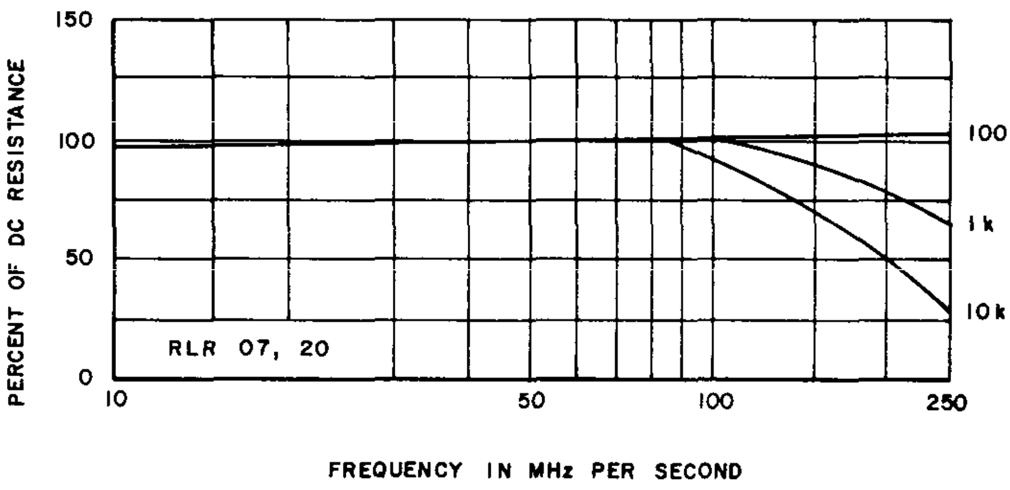


FIGURE 305-2. Response curve.

2.10 Screening requirements. All resistors furnished under MIL-R-39017 are subjected to a conditioning 1.5 x rated power for a duration of 24 hours at a test ambient temperature of 20°C to 45°C. The conditioning is followed by a total resistance check and a visual examination for evidence of arcing, burning, or charring.

2.11 Terminals. Resistors furnished under MIL-R-39017 have leads conforming to type C of MIL-STD-1276. These leads are considered both solderable and weldable.

2.12 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±4.0 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

3. ITEM IDENTIFICATION (see figures 305-3 and 305-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 305-3.

RLR07 C 1002 G M

STYLE: The three-letter symbol "RLR" identifies established reliability, insulated, film, fixed resistors; the two-digit number identifies the physical size and power rating.

TERMINAL: The single-letter symbol "C" identifies a solderable/weldable terminal.

* RESISTANCE: The four-digit number identifies the nominal resistance value, expressed in ohms; the first three digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

10R0- - - - -	10 ohms
1000 - - - -	100 ohms
1001 - - - -	1,000 ohms
1002 - - - -	10,000 ohms
1003 - - - -	100,000 ohms
1004	1,000,000 ohms

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

F - - - -	±1 percent
G - - - -	±2 percent

LIFE FAILURE RATE: The single-letter symbol identifies the life failure rate as follows:

M - - - -	1.0 percent/1,000 hr
P - - - -	0.1 percent/1,000 hr
R - - - -	0.01 percent/1,000 hr
S - - - -	0.001 percent/1,000 hr

FIGURE 305-3. Type designation example.

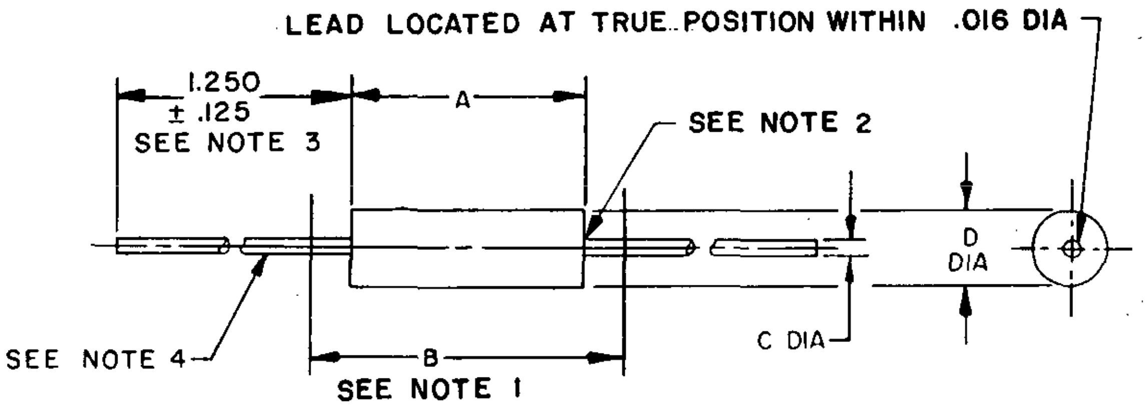
3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 305-I.

3.3 Resistance values. The standard resistance values specified shall follow the decade of values shown in the following tabulation:

Resistance values for the 10 to 100 decade.

G (2.0)	F (1.0)	G (2.0)	F (1.0)	G (2.0)	F (1.0)	G (2.0)	F (1.0)
10.0	10.0	---	18.7	---	33.2	---	56.2
---	10.2	---	19.1	---	34.0	---	57.6
---	10.5	---	19.6	---	34.8	---	59.0
---	10.7	20.0	20.0	---	35.7	---	60.4
11.0	11.0	---	20.5	36.0	---	---	61.9
---	11.3	---	21.0	---	36.5	62.0	---
---	11.5	---	21.5	---	37.4	---	63.4
---	11.8	22.0	---	---	38.3	---	64.9
12.0	---	---	22.1	39.0	---	---	66.5
---	12.1	---	22.6	---	39.2	68.0	---
---	12.4	---	23.2	---	40.2	---	68.1
---	12.7	---	23.7	---	41.2	---	69.8
13.0	13.0	24.0	---	---	42.2	---	71.5
---	13.3	---	24.3	43.0	---	---	73.2
---	13.7	---	24.9	---	43.2	75.0	75.0
---	14.0	---	25.5	---	44.2	---	76.8
---	14.3	---	26.1	---	45.3	---	78.7
---	14.7	---	26.7	---	46.4	---	80.6
15.0	15.0	27.0	---	47.0	---	82.0	---
---	15.4	---	27.4	---	47.5	---	82.5
---	15.8	---	28.0	---	48.7	---	84.5
16.0	---	---	28.7	---	49.9	---	86.6
---	16.2	---	29.4	51.0	---	---	88.7
---	16.5	30.0	---	---	51.1	---	90.9
---	16.9	---	30.1	---	52.3	91.0	---
---	17.4	---	30.9	---	53.6	---	93.1
---	17.8	---	31.6	---	54.9	---	95.3
18.0	---	---	32.4	56.0	---	---	97.6
---	18.20	33.0	---				

STYLES RLR05, RLR07, RLR20, AND RLR32



Standard style	Dimensions (inches)			
	A	B Max	C ±.002	D
RLR05	.150 ±.020	.187	.016 ±.001	.066 ±.008
RLR07	.250 +.031 -.046	.300	.025	.090 ±.008
RLR20	.375 ±.041	.450	.032	.138 ±.023
RLR32	.562 +.031 -.042	.625	.040	.190 ±.015

Inches	mm	Inches	mm	Inches	mm	Inches	mm
.001	.03	.023	.58	.064	1.63	.318	8.08
.002	.06	.025	.64	.066	1.68	.375	9.53
.006	.15	.031	.79	.090	2.29	.380	9.65
.008	.20	.032	.81	.125	3.18	.450	11.43
.015	.38	.040	1.02	.138	3.51	.562	14.27
.016	.41	.041	1.04	.150	3.81	.625	15.88
.018	.46	.042	1.07	.187	4.75	.688	17.48
.020	.51	.045	1.14	.190	4.83	.756	19.20
		.046	1.17	.250	6.35	1.250	33.75
				.300	7.62		

NOTES:
1. Maximum length is "clean lead" to "clean lead".
2. The end of the body is that point at which the body diameter equals the nearest drill size larger than 250 percent* of the nominal lead diameter. *150 percent for RLR07.
3. Length is 1.250 (31.75 mm) ±.266 (6.76 mm) for style RLR05.
4. Lead length for tape and reel packaging shall be 1 inch minimum.

FIGURE 305-4. Established reliability, fixed film resistors (insulated).

TABLE 305-I. Performance characteristics.

Features	Style			
	RLR05	RLR07	RLR20	RLR32
Resistance temperature coefficient (ppm/°C)	±100	±100	±100	±100
Max ambient temperature at full rated wattage	70°C	70°C	70°C	70°C
Max ambient temperature at zero load	150°C	150°C	150°C	150°C
Power rating (watts)	1/8	1/4	1/2	1
Min resistance (ohms)	4.7	10	4.3	10
Max resistance (megohms)	1	22.1	3.01	1.0
Max continuous working voltage (volts)	200	250	350	500
Max percent change in resistance (±): 1/				
Conditioning	0.5	0.5	0.5	0.5
Temperature cycling	0.25	0.25	0.25	0.25
Overload	0.5	0.5	0.5	0.5
Low temperature operation	0.25	0.25	0.25	0.25
Low temperature storage	0.25	0.25	0.25	0.25
Terminal strength	0.25	0.25	0.25	0.25
Dielectric withstanding voltage	0.25	0.25	0.25	0.25
Resistance to soldering heat	0.25	0.25	0.25	0.25
Moisture resistance	1.0	1.0	1.0	1.0
Shock (specified pulse), Vibration, high frequency	0.5	0.5	0.5	0.5
High temperature exposure	2.0	2.0	2.0	2.0
Life:				
Initial qualification (2,000 hr)	2.0	2.0	2.0	2.0
Failure rate determination (10,000 hr)	4.0	4.0	4.0	4.0
Dielectric withstanding voltage:				
Atmospheric	300	500	500	1,000
Barometric	200	250	250	350
Insulation resistance (megohms):				
Dry	1,000	1,000	1,000	1,000
Wet (after moisture resistance)	100	100	100	100

1/ Where total resistance change is 1 percent or less, it shall be considered as ±(_percent +0.05 ohm).

SECTION 306

RESISTORS, FIXED, WIREWOUND (POWER TYPE, CHASSIS MOUNTED), ESTABLISHED RELIABILITY

STYLES RER40, RER45, RER50, RER55, RER60, RER65, RER70, AND RER75

(APPLICABLE SPECIFICATION: MIL-R-39009)

1. SCOPE. This section covers established reliability, chassis-mounted, power type, wirewound, fixed resistors, having a wirewound resistance element and axial lug-type leads. These resistors utilize the principle of heat dissipation through a metal mounting surface with full rated wattage at 25°C. The initial resistance tolerance is ±1.0 percent. These resistors provide life failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level (initial qualification) and maintained at a 10-percent producer's risk. The failure rate is referred to operation at full rated wattage and temperature with a maximum change in resistance of ±2.0 percent at 0 to 10,000 hours of life test. These resistors should not be used in circuits where their ac performance is of critical importance; however, provisions have been made in particular styles to minimize inductance.

2. APPLICATION INFORMATION.

2.1 Construction. The construction of these resistors employs a measured length of resistance wire or ribbon (of a known ohmic value) wound in a precise manner (pitch, effective wire coverage, and wire diameter are specification controlled). Series RER45, 50, and 55 have Ayrton-Perry, or Bifilar windings to reduce inductive effort. The continuous length of wire (wire required to be free of joints, bond, and of uniform cross-section) is wound on a ceramic core or tube and attached to end terminations. The finished resistor element and termination caps are sealed by a coating material. The coated element is then inserted in a finned aluminum alloy housing which completes the sealing of the element from detrimental environments, and provides a radiator and a heat sink for heat dissipation. Due to reliability requirements of MIL-R-39009, processes and controls utilized in manufacturing are necessarily more stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of these requirements.

2.2 Derating at high temperatures. The power rating is based on operation at 25°C when mounted upon the specified test chassis area (see MIL-R-39009 and figure 306-1). When the resistor is to be used in a circuit where the surrounding temperature is higher than 25°C or the chassis area is restricted, the wattage must be reduced so as not to overload the resistor. See figures 306-1 and 306-2 for derating factors.

2.3 Derating for optimum performance. When the chassis area and the anticipated maximum ambient temperatures have been determined, a factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential.

2.4 Choice of style. Resistors to be used in equipment should be so chosen that, when mounted in the equipment, they will not be required to operate at a temperature in excess of their rating. This should be applicable under the most severe conditions as follows:

a. In the maximum specified ambient temperature, limited chassis area.

b. Under conditions producing maximum temperature rise in each resistor.

c. For a sufficient length of time to produce maximum temperature rise, or for the maximum specified time.

d. With all enclosures in place.

e. With natural ventilation only. (This should permit the use of any special ventilating provisions included as a standard part of the equipment.)

f. At high altitude.

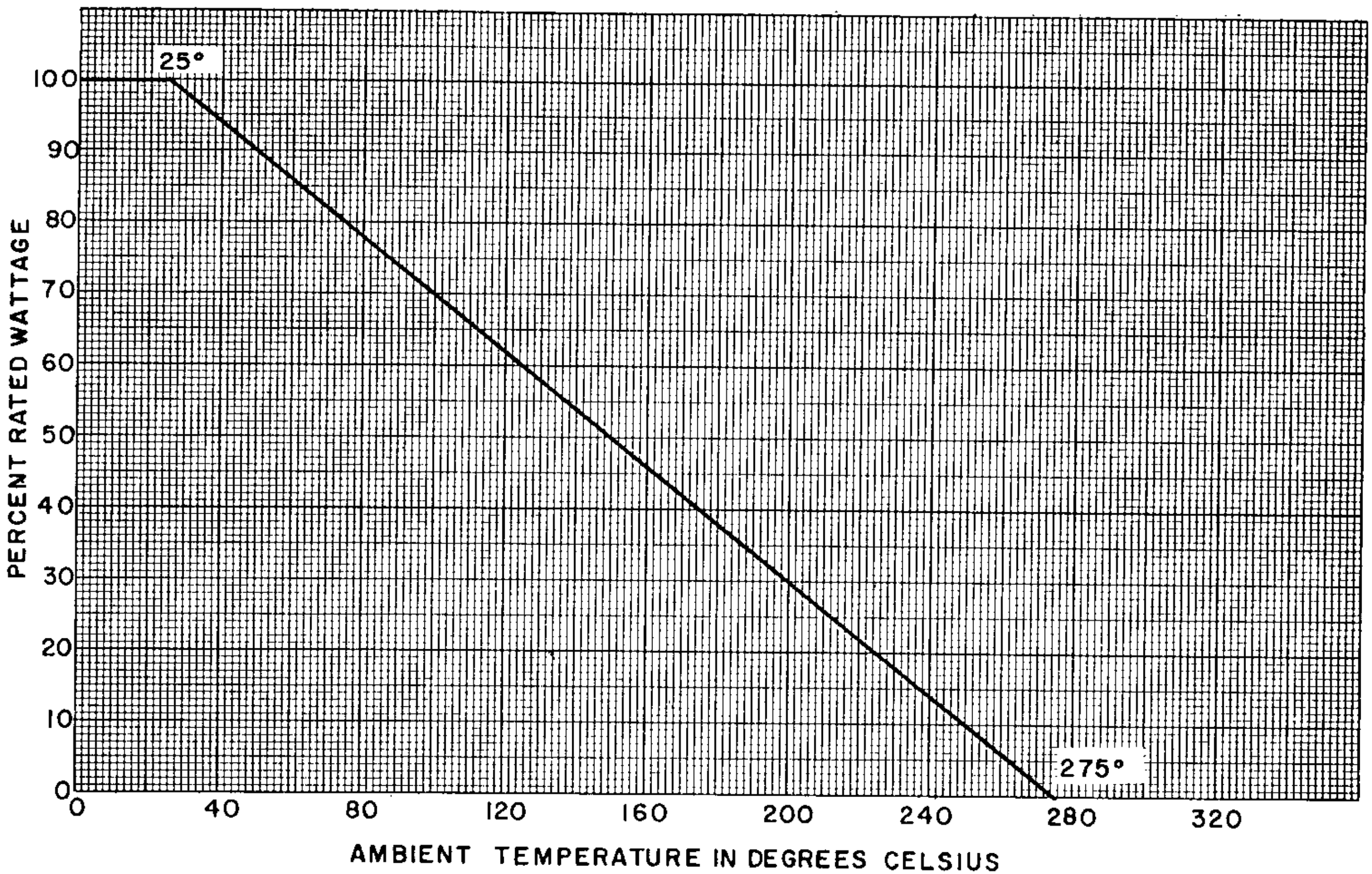
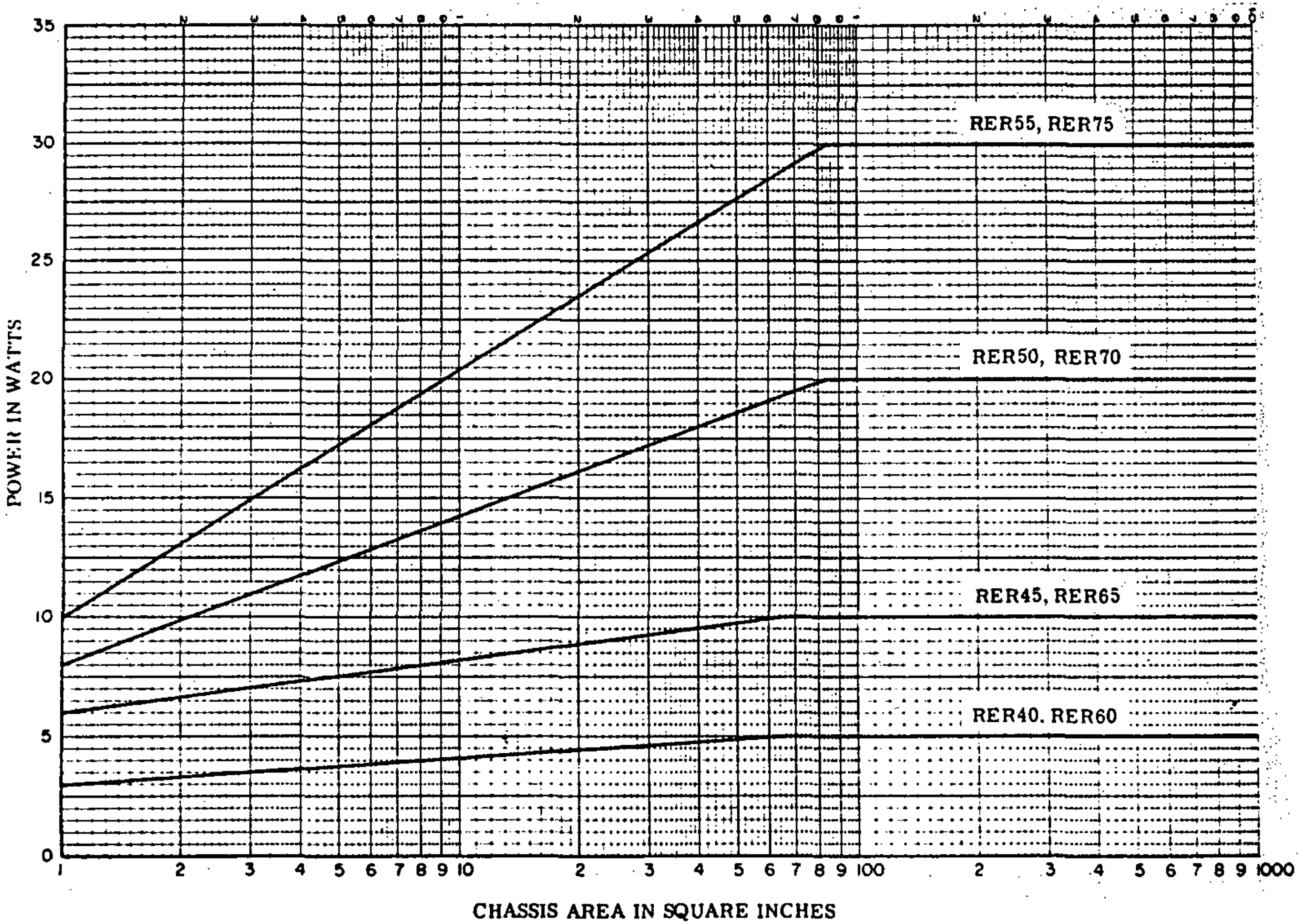


FIGURE 306-1. Derating curve for high ambient temperature.



NOTE: The chassis derating curves are based on the full power ratings at an ambient temperature of 25° C. These curves are independent of the temperature derating curves.

FIGURE 306-2. Chassis-area derating curve.

2.5 Spacing. When resistors are mounted in rows or banks, they should be so spaced that, taking into consideration the restricted ventilation and heat dissipation by nearby resistors, none of the resistors in the row or bank exceeds its maximum permissible continuous operating temperature. An appropriate combination of resistor spacing and resistor power rating must be chosen if this is to be assumed. In view of the chassis heat dissipation principle of these resistors, particular care must be exercised in order that the chassis temperature rise does not damage nearby components.

2.6 Soldering. A solder with a minimum melting temperature of 300°C should be used in soldering.

2.7 Maximum weight. The maximum weight for each style is as follows:

RER40 - - - - - -	3.3 grams
RER45 - - - - - -	8.8 grams
RER50 - - - - - -	16.5 grams
RER55 - - - - - -	35 grams
RER60 - - - - - -	3 grams
RER65 - - - - - -	8 grams
RER70 - - - - - -	15 grams
RER75 - - - - - -	32 grams

2.8 Screening requirements. All resistors furnished under MIL-R-39009 are subjected to a conditioning 100-hour life test by cycling at rated continuous working voltage at 25°C dissipating a wattage equal to the power rating (free air) of the resistor. The conditioning is followed by a total resistance measurement and a visual examination for evidence of mechanical damage.

2.9 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±2.0 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

3. ITEM IDENTIFICATION (see figures 306-3 and 306-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 306-3.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 306-I.

3.3 Resistance values. The resistance values shall follow the decade values shown in the following tabulation:

Resistance values for the 10 to 100 decade - F (1.0%)					
10.00	15.40	22.60	33.00	---	---
10.20	15.80	23.20	33.20	47.50	68.10
10.50	---	23.70	34.00	48.70	69.80
10.70	16.20	---	34.80	49.90	71.50
11.00	16.50	24.30	35.70	---	73.20
11.30	16.90	24.90	---	51.10	75.00
11.50	17.40	25.50	36.50	52.30	76.80
11.80	17.80	26.10	37.40	53.60	78.70
---	---	26.70	38.30	54.90	80.60
12.10	18.20	---	---	---	---
12.40	18.70	27.40	39.20	56.20	82.50
12.70	19.10	28.00	40.20	57.60	84.50
13.00	19.60	28.70	41.20	59.00	86.60
13.30	20.00	29.40	42.20	60.40	88.70
13.70	20.50	---	---	61.90	90.90
14.00	21.00	30.10	43.20	---	---
14.30	21.50	30.90	44.20	63.40	93.10
14.70	---	31.60	45.30	64.90	95.30
15.00	22.10	32.40	46.40	66.50	97.60

RER65 F 1001 M

STYLE: The three-letter symbol "RER" identifies established reliability, chassis-mounted, power type, wirewound, fixed resistors; the two-digit number identifies the physical size and power rating.

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

F - - - - - - - - ±1.0 percent

* RESISTANCE: The four-digit number identifies the nominal resistance value, expressed in ohms; the first three digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:

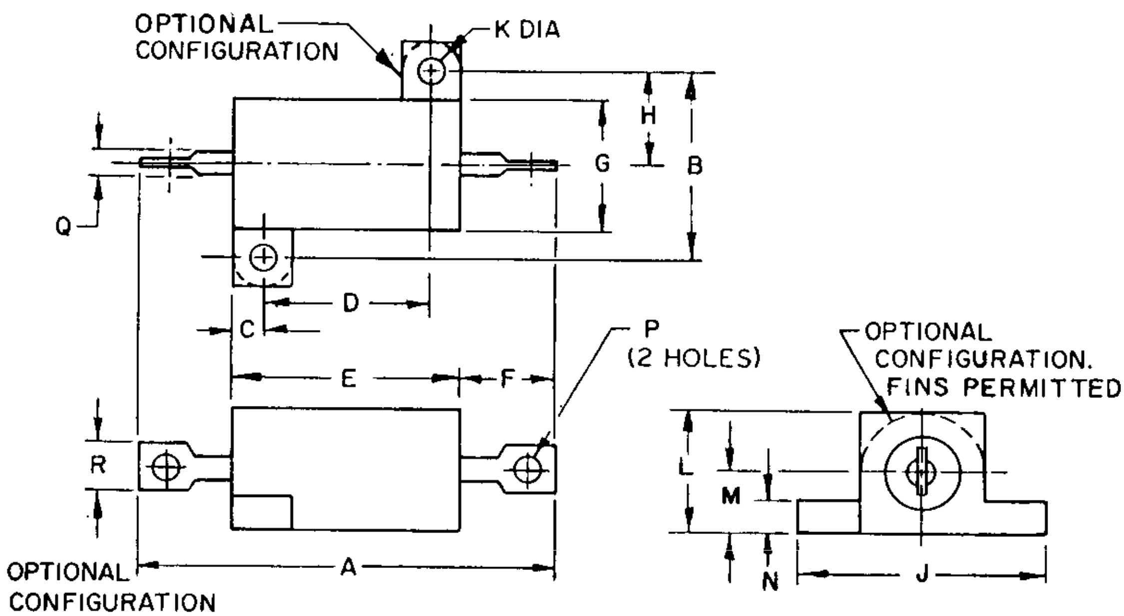
R100- - - - - 0.10 ohm
1R00- - - - - 1.0 ohm
10R0- - - - - 10 ohms
1000- - - - - 100 ohms
1001- - - - - 1,000 ohms

FAILURE RATE LEVEL: The single-letter symbol identifies the life failure rate as follows:

M - - - - - - 1.0 percent/1,000 hr
P - - - - - - 0.1 percent/1,000 hr
R - - - - - - 0.01 percent/1,000 hr *

FIGURE 306-3. Type designation example.

STYLES RER40, RER45, RER50, RER55, RER60, RER65, RER70, AND RER75



Resistor style	A ±.062 (1.57)	B ±.010 (.25)	C ±.031 (.79)	D ±.010 (.25)	E ±.062 (1.57)	F ±.062 (1.57)	G ±.062 (1.57)	H ±.031 (.79)	J ±.031 (.79)	K ±.005 (.13)	L ±.031 (.79)	M ±.062 (1.57)	N ±.031 (.79)	P ±.005 (.13)	Q min AWG	R min
RER40 RER60	1.125 (28.58)	.490 (12.45)	.078 (1.98)	.444 (11.28)	.600 (15.24)	.266 (6.76)	.334 (8.48)	.245 (6.22)	.646 (16.41)	.093 (2.36)	.320 (8.13)	.133 (3.38)	.065 (1.65)	.050 (1.27)	16	.085 (2.16)
RER45 RER65	1.375 (34.93)	.625 (15.88)	.094 (2.39)	.562 (14.27)	.750 (19.05)	.312 (7.92)	.438 (11.13)	.312 (7.92)	.812 (20.62)	.094 (2.39)	.406 (10.31)	.203 (5.16)	.094 (2.39)	.085 (2.16)	12	.140 (3.56)
RER50 RER70	1.938 (49.23)	.781 (19.84)	.172 (4.37)	.719 (18.26)	1.062 (26.97)	.438 (11.13)	.531 (13.49)	.391 (9.93)	1.094 (27.79)	.125 (3.18)	.562 (14.27)	.281 (7.14)	.094 (2.39)	.085 (2.16)	12	.140 (3.56)
RER55 RER75	2.781 (70.64)	.844 (21.44)	.188 (4.78)	1.562 (39.67)	1.938 (49.23)	.438 (11.13)	.594 (15.09)	.422)10.72)	1.156 (29.36)	.125 (3.18)	.625 (15.88)	.312 (7.92)	.094 (2.39)	.085 (2.16)	12	.140 (3.56)

FIGURE 306-4. Established reliability, wirewound (power type, chassis mounted), fixed resistors.

TABLE 306-I. Performance characteristics.

Features		RER60 (RER40) 1/	RER65 (RER45) 1/	RER70 (RER50) 1/	RER75 (RER55) 1/
Max resistance-temperature characteristic ppm/°C-ppm (Ref to 25°C)	20 ohms and above	±30	±30	±30	±30
	1 to 19.60 ohms	±50	±50	±50	±50
	Below 1 ohm	±100	±100	±100	±100
Max ambient temperature at rated wattage		25°C	25°C	25°C	25°C
Max ambient temperature at zero wattage derating		275°C	275°C	275°C	275°C
Min resistance (ohm)		0.10(1.0)	0.10 (1.0)	0.10 (1.0)	0.10 (1.0)
Max resistance (ohms) (based on use of .001" wire)		3,320 (1,650)	5,620 (2,800)	12,100 (6,040)	39,200 (19,600)
Power rating (chassis mounted) in watts		5	10	20	30
Power rating (free air) in watts		3	6	8	10
Max percent change in resistance (±): 2/					
Conditioning		0.2	0.2	0.2	0.2
Temperature		0.5	0.5	0.5	0.5
Dielectric withstanding voltage		0.2	0.2	0.2	0.2
Thermal shock		0.3	0.3	0.3	0.3
Momentary overload		0.3	0.3	0.3	0.3
Moisture resistance		0.5	0.5	0.5	0.5
Terminal strength		0.2	0.2	0.2	0.2
Shock (specified pulse)		0.2	0.2	0.2	0.2
Vibration, high frequency		0.2	0.2	0.2	0.2
High temperature exposure		1.0	1.0	1.0	1.0
Low temperature operation		0.3	0.3	0.3	0.3
Low temperature storage		0.3	0.3	0.3	0.3
Life:					
Qualification (2,000 hr)		1.0	1.0	1.0	1.0
Failure rate determination (10,000 hr)		2.0	2.0	2.0	2.0
Resistance tolerance (±percent)		1.0	1.0	1.0	1.0
Insulation resistance (megohms):					
Dry		10,000	10,000	10,000	10,000
Wet (after moisture resistance)		1,000	1,000	1,000	1,000
Dielectric withstanding voltage:					
Atmospheric pressure (volts)		1,000	1,000	1,000	1,000
Barometric pressure (volts)		500	500	500	500
Terminal strength (direct pull) (lbs)		5, +0,-1/4	5, +0,-1/4	5, +0,-1/4	5, +0,-1/4

1/ Styles listed in parentheses are the minimum inductance versions of the styles not shown in parentheses. All values are identical except the min and max resistance values as noted.

2/ Where total resistance change is 2 percent or less, it shall be considered as ±(_percent +0.05 ohm).

SECTION 307

RESISTORS, FIXED, FILM, CHIP, ESTABLISHED RELIABILITY

STYLES RM0502, RM0505, RM0705, RM1005, RM1505, AND RM2208

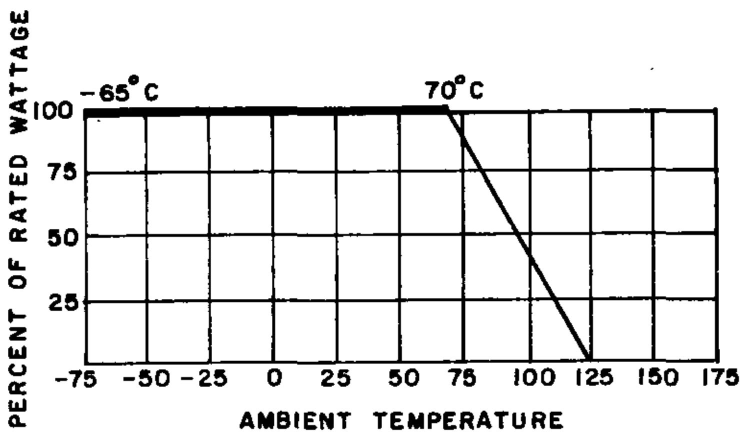
(APPLICABLE SPECIFICATION: MIL-R-55342)

1. *SCOPE. This section covers established reliability, fixed, film, chip* resistors primarily intended for incorporation into hybrid microelectronic circuits. These resistors are uncased, leadless chip devices and possess a high degree of stability with respect to time, under severe environmental conditions. These resistors provide life failure rates ranging from 1.0 percent to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level (initial qualification) and maintained at a 10-percent producer's risk. The failure rate is referred to operation at full rated voltage and rated temperature with a maximum change in resistance of ±2.0 percent at 0 to 10,000 hours of life test.

2. APPLICATION INFORMATION.

2.1 Construction. The resistance element consists of a film element on a ceramic substrate. The element is formed either by deposition of a vaporized metal or the printing of a metal and glass combination paste which has then been fired at a high temperature. Resistance elements are generally rectangular in shape and calibrated to the proper resistance value by trimming the element by abrasion or a laser beam. Due to the reliability requirements of MIL-R-55342, processes and controls utilized in manufacturing are necessarily more stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications", provides for monitoring and documentation of these requirements.

2.2 Derating at high temperatures. The power rating is based on operation at 70°C. However, when a resistor is to be used in a circuit where the surrounding temperature is higher than 70°C, a correction factor must be applied to the wattage rating so as not to overload the resistor. The correction factor may be taken from the curve shown on figure 307-1.



NOTE: This curve indicates the percentage of nominal wattage to be applied at temperatures higher than 70°C. This curve applies only to units mounted on a substrate; however, the applied voltage does not exceed the maximum for each style.

FIGURE 307-1. Derating curve for high ambient temperatures.

2.3 Derating for optimum performance. Because all of the electrical energy dissipated by a resistor is converted into heat energy, the temperature of the surrounding air is an influencing factor when selecting a particular resistor for a specific application. The power rating of these resistors is based on operation at specific temperatures; however, in actual use, the resistor may not be operating at these temperatures. When the desired characteristic and the anticipated maximum ambient temperatures have been determined, a safety factor of 2, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential.

2.4 Resistance tolerance. Designers should bear in mind that operation of these resistor chips under the ambient conditions for which military equipment is designed may cause permanent or temporary changes in resistance sufficient to exceed their initial tolerances. In particular, operation at extremely high or low ambient temperatures may cause significant temporary changes in resistance.

2.5 Voltage limitations. Because of the very small size of the resistance elements and connecting circuits, there are maximum permissible voltages which are imposed. The maximum voltage permissible for each style is shown in table 307-I.

2.6 Noise. Noise output is not controlled by specification, but for these resistors, noise is a negligible quantity. In applications where noise is an important factor, resistors in these chips are superior to composition types. Where noise test screening is indicated, it is recommended that MIL-STD-202, method 308, be used.

2.7 Moisture resistance. These resistor chips are essentially unaffected by moisture. The specification allows only a 0.5 percent change in resistance value as a result of exposure to a standard 10-day moisture resistance test.

2.8 Electrostatic charge effects. Under relatively low humidity conditions, some types of film resistors, particularly those with small dimensions and high sheet resistivity materials, are prone to sudden significant changes in resistance (usually reductions in value) and to changes in temperature coefficient of resistance as a result of discharge of static charges built up on associated objects during handling, packaging, or shipment. Substitution of more suitable implements and materials can help minimize this problem. For example, use of cotton gloves, static eliminator devices, air humidifiers, and operator and work bench grounding systems can reduce static buildup during handling. Means of alleviating static problems during shipment include elimination of loose packaging of resistors and use of metal foil and anti-static (partly conducting) plastic packaging materials.

2.9 High frequency application. When used in high frequency circuits (200 megahertz and above), the effective resistance will be reduced as a result of shunt capacity between resistance elements and connecting circuits. The high frequency characteristics of these chips are not controlled.

2.10 Mounting. Under severe shock or vibration conditions (or a combination of both), resistors should be mounted so that the body of the resistor chip is restrained from movement with respect to the mounting base. If clamps are used, certain electrical characteristics may be altered. The heat-dissipating qualities will be enhanced or retarded depending on whether the clamping material is a good or poor heat conductor.

2.11 Screening. All resistor chips furnished under MIL-R-55342 are subject to 100 percent screening through a thermal shock test. This test is followed by a total resistance check and a visual examination for evidence of mechanical damage.

2.12 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±2.0 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

3. ITEM IDENTIFICATION (see figures 307-2 and 307-3).

3.1 Part number. The part number is used for identifying and describing the resistor as shown on figure 307-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 307-I.

3.3 Resistance values. Resistance values shall follow the decade of values as shown in the following tabulation:

Standard resistance values for the 10 to 100 decade for 1.0%, 2.0%, 5.0%, and 10.0% resistance tolerances

Resistance tolerance														
F (1.0)	G (2.0) J (5.0)	K (10.5)	F (1.0)	G (2.0) J (5.0)	K (10.0)	F (1.0)	G (2.0) J (5.0)	K (10.0)	F (1.0)	G (2.0) J (5.0)	K (10.5)	F (1.0)	G (2.0) J (5.0)	K (10.0)
10.00	10.00	10.00	17.80	---	---	---	---	---	51.10	---	---	86.60	---	---
---	---	---	---	18.00	---	30.90	---	---	---	---	---	---	---	---
10.20	---	10.20	18.20	---	---	---	---	---	52.30	---	---	88.70	---	---
---	---	---	---	---	---	31.60	---	---	---	---	---	---	---	---
10.50	---	10.50	18.70	---	---	---	---	---	53.60	---	---	90.90	---	---
---	---	---	---	---	---	32.40	---	---	---	---	---	---	---	---
10.70	---	---	19.10	---	---	---	---	---	54.90	---	---	---	91.00	---
---	---	10.80	---	---	---	---	33.00	33.00	---	---	---	93.10	---	---
11.00	11.00	---	19.60	---	---	33.20	---	---	---	56.00	56.00	---	---	---
---	---	---	---	---	---	---	---	---	56.20	---	---	95.30	---	---
11.30	---	---	20.00	20.00	---	34.00	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	57.60	---	---	97.60	---	---
11.50	---	---	20.50	---	---	34.80	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	59.00	---	---			
11.80	---	---	21.00	---	---	35.70	---	---	---	---	---			
---	12.00	---	---	---	---	---	36.00	---	60.40	---	---			
12.10	---	---	21.50	---	---	---	---	---	---	---	---			
---	---	---	---	---	---	36.50	---	---	61.90	---	---			
12.40	---	---	---	22.00	22.00	---	---	---	---	62.00	---			
---	---	---	22.10	---	---	37.40	---	---	---	---	---			
12.70	---	---	---	---	---	---	---	---	63.40	---	---			
---	---	---	22.60	---	---	38.30	---	---	---	---	---			
13.00	13.00	---	---	---	---	---	---	---	64.90	---	---			
---	---	---	23.20	---	---	---	39.00	39.00	---	---	---			
13.30	---	---	---	---	---	39.20	---	---	66.50	---	---			
---	---	---	23.70	---	---	---	---	---	---	---	---			
13.70	---	---	---	24.00	---	40.20	---	---	---	68.00	68.00			
---	---	---	24.30	---	---	---	---	---	68.10	---	---			
14.00	---	---	---	---	---	41.20	---	---	---	---	---			
---	---	---	24.90	---	---	---	---	---	69.80	---	---			
14.30	---	---	---	---	---	42.20	---	---	---	---	---			
---	---	---	25.50	---	---	---	---	---	71.50	---	---			
14.70	---	---	---	---	---	---	43.00	---	---	---	---			
---	---	---	26.10	---	---	43.20	---	---	73.20	---	---			
15.00	15.00	---	---	---	---	---	---	---	---	---	---			
---	---	---	26.70	---	---	44.20	---	---	75.00	75.00	---			
15.40	---	---	---	27.00	27.00	---	---	---	---	---	---			
---	---	---	---	---	---	45.30	---	---	76.80	---	---			
15.80	---	---	27.40	---	---	---	---	---	---	---	---			
---	16.00	---	---	---	---	46.40	---	---	78.70	---	---			
16.20	---	---	28.00	---	---	---	47.00	47.00	---	---	---			
---	---	---	---	---	---	47.50	---	---	80.60	---	---			
16.50	---	---	28.70	---	---	---	---	---	---	---	---			
---	---	---	---	---	---	48.70	---	---	---	82.00	82.00			
16.90	---	---	29.40	---	---	---	---	---	82.50	---	---			
---	---	---	---	---	---	49.90	---	---	---	---	---			
17.40	---	---	---	30.00	---	---	---	---	84.40	---	---			
---	---	---	30.10	---	---	---	51.00	---	---	---	---			

M55342/1- K 1003 F S M

SPECIFICATION NUMBER: The number identifies the detail specification number (indicating MIL-R-55342/1).

CHARACTERISTIC: The single-letter symbol identifies the characteristic (see table 307-I) as follows:

K - - - +100 ppm/°C; 70°C maximum ambient temperature at rated wattage
M - - - +300 ppm/°C; 70°C maximum ambient temperature at rated wattage

RESISTANCE: The nominal resistance expressed in ohms is identified by either three or four digits depending upon the resistance tolerance. For resistance tolerances of 1 percent and lower, four digits are used; the first three digits represent significant figures and the last digit specifies the number of zeros to follow. For resistance tolerances of 2 percent and higher, three digits are used; the first two digits representing significant figures and the last digit
* specifies the number of zeros to follow. For values less than 100 ohms and resistance tolerances 1 percent or better or values less than 10 ohms with resistance tolerance 2 percent or greater, the letter "R" shall be used to signify the decimal point and all digits are significant.

EXAMPLES:

1R00- - - -	1Ω	1R0- - - -	1Ω
10R0- - - -	10Ω	100- - - -	10Ω
1000- - - -	100Ω	101- - - -	100Ω
1001- - - -	1,000Ω	102- - - -	1,000Ω
1002- - - -	10,000Ω	103- - - -	10,000Ω
1003- - - -	100,000Ω	104- - - -	100,000Ω
1004- - - -	1,000,000Ω	105- - - -	1,000,000Ω

RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

F - - - - ±1 percent
G - - - - ±2 percent
J - - - - ±5 percent
K - - - - ±10 percent

TERMINATION: The single-letter symbol identifies termination material, type termination, and termination area as follows:

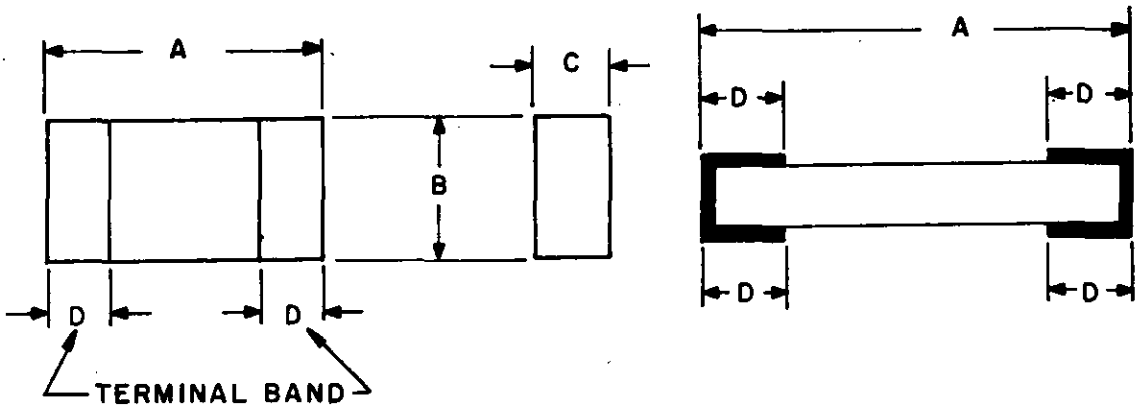
Type	Material	Termination area	Code letters
Solderable	Pretinned	One surface	S
		Wrap around	R
Weldable	Gold	One surface	W
Solderable/ Weldable	Palladium/silver	One surface	D
		Wrap around	C
Solderable/ Weldable	Platinum/gold	One surface	T
		Wrap around	U
* Solderable	Base metallization barrier metal, solder coated	Wrap around	B

LIFE FAILURE-RATE DESIGNATION: The single-letter symbol identifies the life failure rate as follows:

M - - - - - - 1.0 percent per/1,000 hours
P - - - - - - 0.1 percent per/1,000 hours
R - - - - - - 0.01 percent per/1,000 hours

FIGURE 307-2. Part number example.

307B (MIL-R-55342)



Covers termination materials C, U, and R which are wrap around terminations.

Covers termination materials S, W, D, and T.

* Also applicable to termination C, U and R.

Termination material designation.

Type	Material	Termination area	Code letters
Solderable	Pretinned	One surface Wrap around	S R
Weldable	Gold	One surface	W
Solderable/Weldable	Palladium/silver	One surface Wrap around	D C
* Solderable/Weldable	Platinum/gold	One surface Wrap around	T U
Solderable	Base metallization barrier metal, solder coated	Wrap around	B

FIGURE 307-3. Established reliability, fixed film chip resistors.

Specification number	Termination	Dimension (inch) A	B	C	D	Style
MIL-R-55342/1	R	.050 +.025 -.005	.025 +.010 -.005	.010/.040	.016 ±.011	RM0502
	U	.050 +.011 -.005			.015 +.005 -.010	
	S, W, T	.050 1/			.010 1/	
MIL-R-55342/2	R	.050 +.025 -.005	.050 +.010 -.005	.010/.040	.016 ±.011	RM0505
	U	.050 +.011 -.005			.015 +.005 -.010	
	S, W, T	.050 1/			.010 1/	
MIL-R-55342/3	R	.100 +.025 -.005	.050 +.010 -.005	.010/.040	.021 ±.011	RM1005
	U	.100 +.011 -.005			.017 +.008 -.007	
	S, W, T	.100 1/			.015 1/	
MIL-R-55342/4	R	.150 +.025 -.005	.050 +.010 -.005	.010/.040	.021 ±.011	RM1505
	U	.150 +.011 -.005			.017 +.008 -.007	
	S. W. T.	.150 1/			.015 1/	
MIL-R-55342/5	R	.225 +.025 -.005	.075 +.010 -.005	.010/.040	.022 +.013 -.012	RM2208
	U	.225 +.011 -.005			.020 ±.010	
	S, W, T	.225 1/			.015 1/	
MIL-R-55342/6	R	.075 +.025 -.005	.050 +.010 -.005	.010/.040	.021 ±.011	RM0705
	U	.075 +.011 -.005			.017 +.008 -.007	
	S, W, T	.075 1/			.015 1/	

1/ Tolerance is ±.005

NOTE: The pictorial views of the styles above are given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.

FIGURE 307-3. Established reliability, fixed film chip resistors - Continued.

TABLE 307-I. Performance characteristics.

Features	K	M
Resistance temperature characteristic, ppm°C- - - -	±100	±300
Maximum ambient temperature at rated wattage- - - -	70°C	70°C
Maximum ambient temperature at zero power dc rating	125°C	125°C
Maximum operating voltage for each resistor (volts)		
M55342/1- -	40	40
M55342/2- -	40	40
M55342/3- -	40	40
M55342/4- -	40	40
M55342/5- -	40	40
M55342/6- -	50	50
Power rating (watts) at 70°C:		
M55342/1- -	.020	.020
M55342/2- -	.050	.050
M55342/3- -	.100	.100
M55342/4- -	.150	.150
M55342/5- -	.225	.225
M55342/6- -	.100	.100
Minimum and maximum resistance values (ohms):	Min	Max
M55342/1		
Resistance tolerance B - - - - - - - - - - - - - - -	100	.1 MΩ
Resistance tolerance F - - - - - - - - - - - - - - -	10	.1 MΩ
Resistance tolerance G - - - - - - - - - - - - - - -	10	.1 MΩ
Resistance tolerance J - - - - - - - - - - - - - - -	10	.1 MΩ
Resistance tolerance K - - - - - - - - - - - - - - -	5.6	.1 MΩ
M55342/2		
Resistance tolerance B - - - - - - - - - - - - - - -	100	.2 MΩ
Resistance tolerance F - - - - - - - - - - - - - - -	10	.294 MΩ
Resistance tolerance G - - - - - - - - - - - - - - -	10	.47 MΩ
Resistance tolerance J - - - - - - - - - - - - - - -	10	47 MΩ
Resistance tolerance K - - - - - - - - - - - - - - -	5.6	47 MΩ
M55342/3		
Resistance tolerance B - - - - - - - - - - - - - - -	100	.3 MΩ
Resistance tolerance F - - - - - - - - - - - - - - -	10	499 MΩ
Resistance tolerance G - - - - - - - - - - - - - - -	10	1 MΩ
Resistance tolerance J - - - - - - - - - - - - - - -	10	1 MΩ
Resistance tolerance K - - - - - - - - - - - - - - -	5.6	1 MΩ

TABLE 307-I. Performance characteristics - Continued.

Features	K	M
M55342/4		
Resistance tolerance B	100	.5 MΩ
Resistance tolerance F	10	1 MΩ
Resistance tolerance G	10	4.7 MΩ
Resistance tolerance J	10	4.7 MΩ
Resistance tolerance K	5.6	4.7 MΩ
M55342/5		
Resistance tolerance B	100	1 MΩ
Resistance tolerance F	10	2 MΩ
Resistance tolerance G	10	15 MΩ
Resistance tolerance J	10	15 MΩ
Resistance tolerance K	5.6	15 MΩ
M55342/6		
Resistance tolerance B	100	.3 MΩ
Resistance tolerance F	10	.499 MΩ
Resistance tolerance G	10	1 MΩ
Resistance tolerance J	10	1 MΩ
Resistance tolerance K	5.6	1 MΩ
Maximum percent change in resistance (0.01 ohm additional allowed for measurement error):		
Thermal shock 1/	±.5 percent	±.5 percent
Low temperature operation	±.25 percent	±.5 percent
Short time overload	±.25 percent	±.5 percent
High temperature exposure	±.5 percent	±1.0 percent
Resistance to bonding exposure	±.25 percent	±.25 percent
Moisture resistance	±.5 percent	±.5 percent
Life (2,000 hours)	±.5 percent	±2.0 percent

1/ Maximum ambient temperature is 150°C.

SECTION 308

RESISTOR, FIXED, PRECISION

ESTABLISHED RELIABIILITY

(APPLICABLE SPECIFICATION: MIL-R-122)

1. SCOPE.

1.1 Scope. This section covers the general requirements for hermetically sealed, and nonhermetically sealed, high precision, low reactance, fixed resistors that possess a high degree of stability with respect to time under severe environmental conditions, with established reliability. Resistors covered in this section have failure rates ranging from 1 percent to 0.001 percent per 100 hours. Failure rates are based upon 60 percent confidence on basis of life tests.

2. APPLICABLE INFORMATION.

2.1 Style selection. Hermetically sealed resistor is one in which the resistive element is contained within a sealed enclosure of ceramic, glass, or metal, or combinations of both, where sealing is accomplished by material fusion, welding, brazing or soldering.

2.2 Power rating. Resistors shall have a reference power rating (100 percent) based upon continuous pull load operation at an ambient temperature of 125°C. However these resistors styles shall be capable of operating at anypoint under the applicable rating curve for the particular resistor style. At no time shall the voltage applied to the resistor exceed the maximum voltage for the selected resistor style.

2.2.1 Derating per optimum performance. Resistors shall have a power rating based upon continuous pull-load operation at an ambient temperature of 125°C. For temperatures higher than 125°C the load shall be derated in accordance with figure 308-1.

2.3 Resistive tolerances. Designers should bear in mind that operation of these resistors under ambient temperatures conditions for which military equipment is designed may cause permanent or temporary changes in resistance sufficient to exceed their initial tolerances. In particular, operation at extremely high or low ambient temperatures may cause significant temporary changes resistance.

2.4 Noise. When resistors are tested in accordance with MIL-STD-202, the current noise shall not exceed -32DB maximum.

2.5 Moisture resistance. Resistors are tested in accordance with MIL-STD-202, the change in resistance for nonhermetically sealed resistors shall not exceed ±(.05 percent ±.001Ω). For hermetically sealed resistors, the change in resistance shall not exceed ±(.01 percent ±.001Ω).

2.6 Storage shelf life. MIL-R-122 estimates a change of but not to exceed ±(.0025 percent ±.001Ω) for hermetically sealed resistors and ±(.005 percent ±.001Ω) for nonhermetically sealed resistors.

2.7 Mounting. Under conditions of severe shock or vibration (or a combination of both), resistors should be mounted in such a way that the body of the resistor is restrained from movement with respect to the mounting base. It should be noted that if clamps are used, certain electrical characteristics of the resistor will be altered. The heat-dissipative qualities of the resistor will be enhanced or retarded depending on whether the clampling material is a good or poor heat conductor.

2.8 Screening. All resistors furnished under MIL-R-55182 are subject to conditioning through thermal shock, overload testing, and power conditioning.

2.9 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occuring in an unpredictable manner, and in too short period of time to permit detection through normal preventative maintenance. Failure factors are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastropic failures" and will differ from failure rates established in the specification, since the established failure rate is based on a "parameter's failure" of ±20 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions. Since MIL-HDBK-217 does not currently specify the reliability prediction for these resistors the model established for MIL-R-55182 should be used until these resistor styles are induced in the handbook.

3. ITEM IDENTIFICATION (see figures 308-2 and 308-3).

M122 A 01 M 4775A75

a. Military specification number (M122)

b. The reactance is identified by a single letter in accordance with table 308-I. (A)

c. Specification sheet (01)

d. Resistance tolerance and life failure rate is identified by a single letter in accordance with table 308-II. (M)

e. Resistance value, temperature characteristic, and decimal point: The nominal resistance value expressed in ohms is identified by seven (7) characters consisting of six (6) digits and one letter symbol. The digits represent significant figures and the letter symbol represents the temperature characteristic, decimal point location, and multipler in accordance with table 308-III. All digits preceeding and following the symbol letter represents significant features. Minimum and maximum resistance values shall be specified. The standard values for every decade shall follow the sequence specified in table 308-V for tolerances 1.0 and 0.5. The resistance values for tolerances 0.1, 0.05, 0.01, and 0.005 may be any value within specified limits. (4775A75)

* 3.1 Performance characteristics. The performance characteristics of these resistors are as shown in table 302-VI.

* TABLE 308-I. Reactance.

Frequency					
≤ 10 kHz		≤ 1 MHz		≤ 100 MHz	
Code	Limits 1/	Code	Limits 1/	Code	Limits 1/
A	≤ 1	F	≤ 1	L	≤ 1
B	≤ 3	G	≤ 3	M	≤ 3
C	≤ 10	H	≤ 10	N	≤ 10
D	≤ 30	J	≤ 30	P	≤ 30
E	uncontrolled	K	uncontrolled	S	uncontrolled

1/ Maximum percentage change in the initial impedance at zero hertz (nominal resistance) due to all reactive components, for all frequencies, up to and including the frequency specified.

TABLE 308-II. Resistance and failure rate designation.

Tolerance % ±	% 1000 Hours failure rate	Symbol
.005	1.0	A
.005	0.1	B
.005	0.01	C
.005	0.001	D
.01	1.0	E
.01	0.1	F
.01	0.01	G
.01	0.001	H
.05	1.0	I
.05	0.1	J
.05	0.01	K
.05	0.001	L
0.1	1.0	M
0.1	0.1	N
0.1	0.01	O
0.1	0.001	P
0.5	1.0	Q
0.5	0.1	R
0.5	0.01	S
0.5	0.001	T
1.0	1.0	U
1.0	0.1	V
1.0	0.01	W
1.0	0.001	X

TABLE 308-III. Resistance temperature characteristic and multipler.

RTC code 1/	Decimal point 2/ multiplier	Symbol
Y	R	A
Y	K	B
A	R	C
A	K	D
B	R	E
B	K	F
C	R	G
C	K	H
D	R	J
D	K	K
E	R	L
E	K	M
F	R	N
F	K	P
G	R	Q
G	K	R

1/ See table 308-IV for RTC codes.
2/ The decimal point and multiplier letter sybol representing the R(X1) multiplier in table 308-III is used to represent values less than 1000 ohms. The letter symbol representing the K(X1000) multiplier is used for all values greater than 1000 ohms.

TABLE 308-IV. Characteristic.

RTC code	Resistance temperature characteristic (referenced to 25°C) ppm/°C — Temperature °C: -55 Min	-55 Max	-15 Min	-15 Max	+65 Min	+65 Max	+125 Min	+125 Max	+150 Min	+150 Max	+175 Min	+175 Max
Y	-0	+5	-1.5	3.5	-4	1	-5	0	-5.5	-.5	-7	-1
A	-2.5	2.5	-2.5	2.5	-2.5	2.5	-2.5	2.5	-3.5	3.5	-4.5	4.5
B	-5	5	-5	5	-5	5	-5	5	-6	6	-7	7
C	-10	10	-10	10	-10	10	-10	10	-12	12	-15	15
D	-2.5	2.5	-1.5	1.5	-1.5	1.5	-2.5	2.5	-3.5	3.5	-4.5	4.5
E	-5	5	-2.5	2.5	-2.5	2.5	-5	5	-6	6	-7	7
F	-10	10	-5	5	-5	5	-10	10	-12	12	-15	15
G	-.7	3.7	.7	2.3	-2.8	.2	-3.3	-.3	-4.1	-1.1	-4.5	-1.5

TABLE 308-V. Standard resistance values for the 10 to 100 decade.

Resistance tolerance (0.5)	(1.0)	(0.5)	(1.0)	(0.5)	(1.0)	(0.5)	(1.0)	(0.5)	(1.0)	(0.5)	(1.0)
10.0	10.0	14.7	14.7	21.5	21.5	31.6	31.6	46.4	46.4	68.1	68.1
10.1	---	14.9	---	21.8	---	32.0	---	47.0	---	69.0	---
10.2	10.2	15.0	15.0	22.1	22.1	32.4	32.4	47.5	4.75	69.8	69.8
10.4	---	15.2	---	22.3	---	32.8	---	48.1	---	70.6	---
10.5	10.5	15.4	15.4	22.6	22.6	33.2	33.2	48.7	48.7	71.5	71.5
10.6	---	15.6	---	22.9	---	33.6	---	49.3	---	72.3	---
10.7	10.7	15.8	15.8	23.2	23.2	34.0	34.0	49.9	49.9	73.2	73.2
10.9	---	16.0	---	23.4	---	34.3	---	50.5	---	74.1	---
11.0	11.0	16.2	16.2	23.7	23.7	34.8	34.8	51.1	51.1	75.0	75.0
11.1	---	16.4	---	24.0	---	35.2	---	51.7	---	75.9	---
11.3	11.3	16.5	16.5	24.3	24.3	35.7	35.7	52.3	52.3	76.8	76.8
11.4	---	16.7	---	24.6	---	36.1	---	53.0	---	77.7	---
11.5	11.5	16.9	16.9	24.9	24.9	36.5	36.5	53.6	53.6	78.7	78.7
11.7	---	17.2	---	25.2	---	37.0	---	54.2	---	79.6	---
11.8	11.8	17.4	17.4	25.5	25.5	37.4	37.4	54.9	54.9	80.6	80.6
12.0	---	17.6	---	25.8	---	37.9	---	55.6	---	81.6	---
12.1	12.1	17.8	17.8	26.1	26.1	38.3	38.3	56.2	56.2	82.5	82.5
12.3	---	18.0	---	26.4	---	38.8	---	56.9	---	83.5	---
12.4	12.4	18.2	18.2	26.7	26.7	39.2	39.2	57.6	57.6	84.5	84.5
12.6	---	18.4	---	27.1	---	39.7	---	58.3	---	85.6	---
12.7	12.7	18.7	18.7	27.4	27.4	40.2	40.2	59.0	59.0	86.6	86.6
12.9	---	18.9	---	27.7	---	40.7	---	59.7	---	87.6	---
13.0	13.0	19.1	19.1	28.0	28.0	41.2	41.2	60.4	60.4	88.7	88.7
13.2	---	19.3	---	28.4	---	41.7	---	61.2	---	89.8	---
13.3	13.3	19.6	19.6	28.7	28.7	42.2	42.2	61.9	61.9	90.9	90.9
13.5	---	19.8	---	29.1	---	42.7	---	62.6	---	92.0	---
13.7	13.7	20.0	20.0	29.4	29.4	43.2	43.2	63.4	63.4	93.1	93.1
13.8	---	20.3	---	29.8	---	43.7	---	64.2	---	94.2	---
14.0	14.0	20.5	20.5	30.1	30.1	44.2	44.2	64.9	64.9	95.3	95.3
14.2	---	20.8	---	30.5	---	44.8	---	65.7	---	96.5	---
14.3	14.3	21.0	21.0	30.9	30.9	45.3	45.3	66.5	66.5	97.6	97.6
14.5	---	21.3	---	31.2	---	45.9	---	67.3	---	98.8	---

TABLE 308-VI. Performance characteristics.

	Style			
	RFP01	RFP03	RFP06	RFP10
Power rating	.3 watt 125°C	.3 watt 125°C	.10 watt 85°C	.15 watt 125°C
Minimum resistance	10Ω	10Ω	10Ω	10Ω
Maximum resistance	.200 MΩ	.200 MΩ	.500 MΩ	.400 MΩ
Maximum continuous voltage	300 V	300 V	200 V	200 V
Low temperature operation	±.01	±.01	±.01	±.01
Terminal strength	±.01	±.01	±.01	±.01
Dielectric withstanding voltage	±.01	±.01	±.01	±.01
Resistranc to soldering heat	±.01	±.01	±.01	±.01
Moisture resistance	±.02	±.01	±.01	±.01
Life	±.2	±.2	±.2	±.01
Shock	±.01	±.01	±.01	±.01
Vibration high frequency	±.01	±.01	±.01	±.01
Dielectric withstanding voltage				
Atmosphereic	300	300	450	500
Barometeric	200	200	200	200
Insulation resistance (megohms)				
Dry	10,000	10,000	10,000	10,000
Wet	100	100	100	100

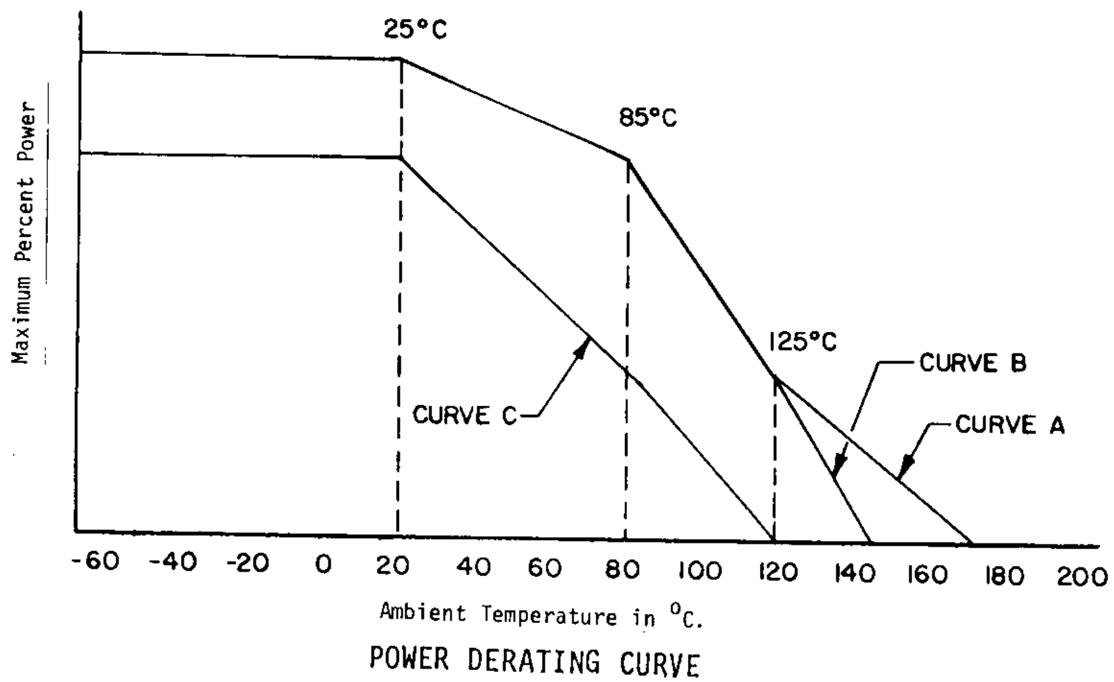
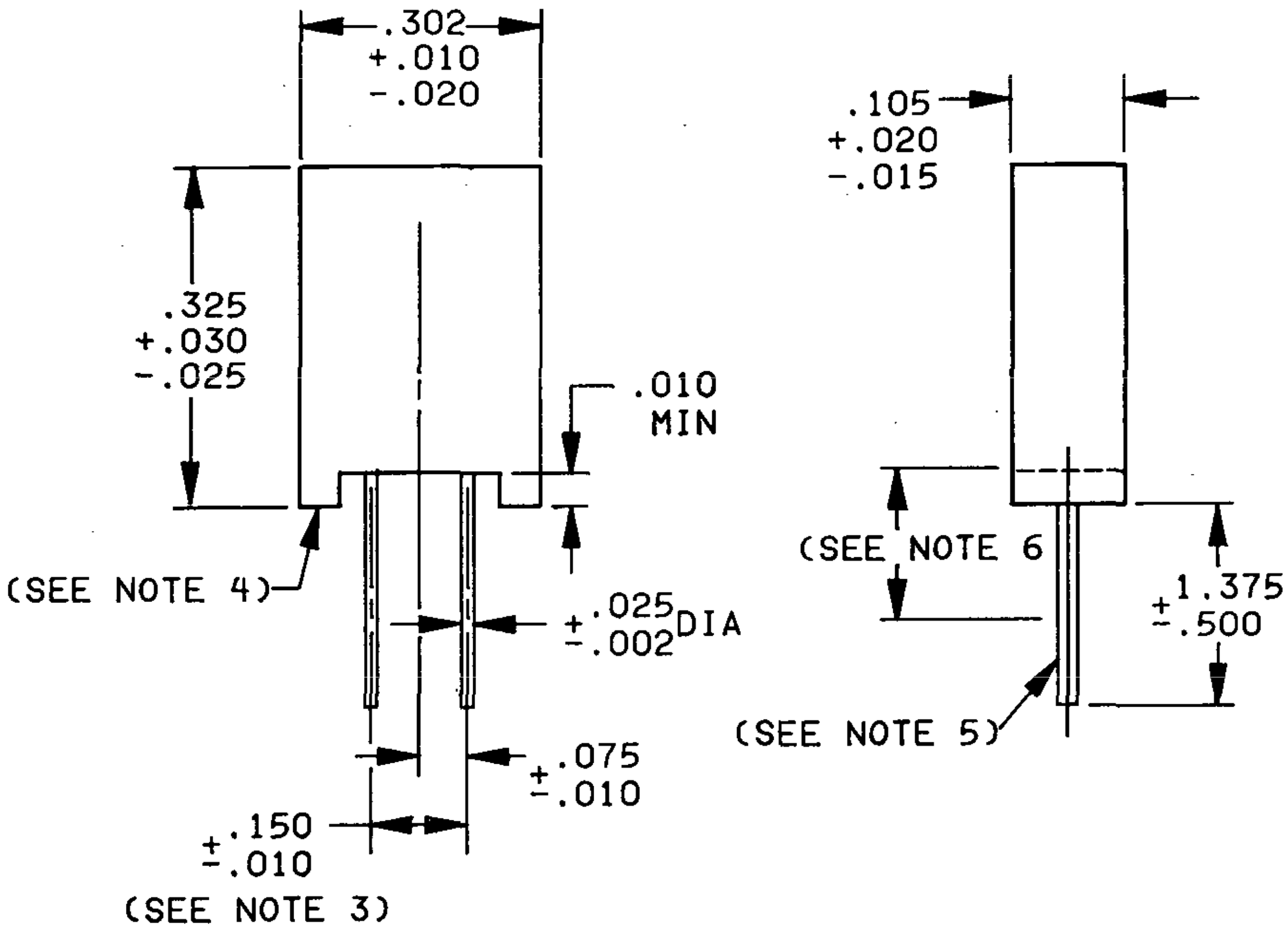


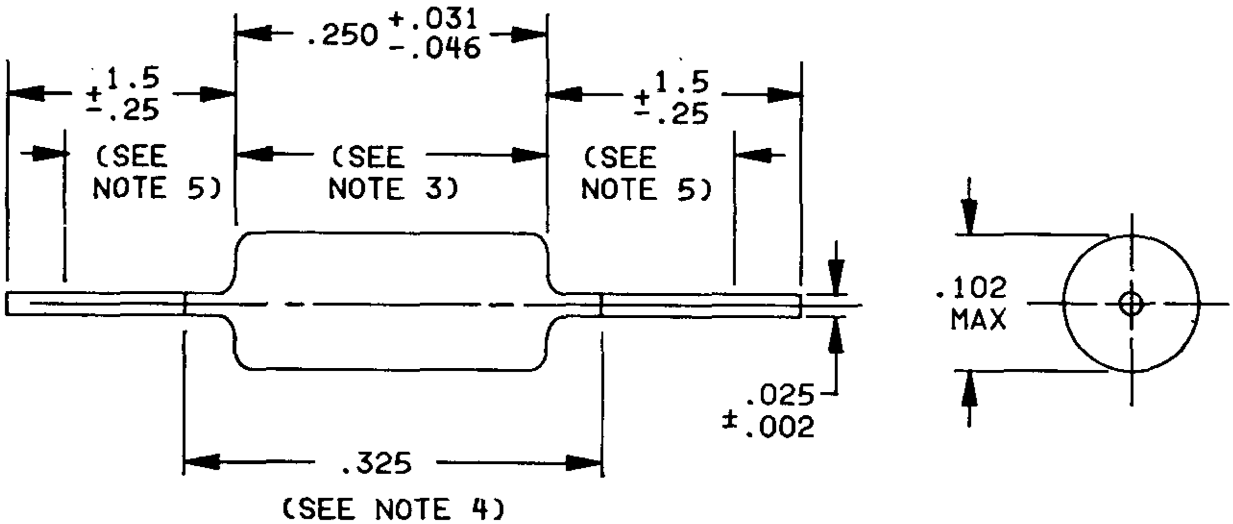
FIGURE 308-1. Power derating curve.



Inches	mm	Inches	mm
.002	0.05	.105	2.67
.010	0.25	.125	3.18
.015	0.38	.150	3.81
.020	0.51	.302	7.67
.025	0.64	.325	8.26
.030	0.76	.500	12.70
.0625	1.588	1.375	34.93
.075	1.91		

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The lead measurements shall be made at the point of emergence from the body.
4. Style and placement of the standoffs are optional.
5. Centerline of terminal shall coincide with the centerline of the body within ±.010 inch.
6. Resistance measuring point shall be .5 ±.125 inch for resistance values of 10Ω or more and .0625 ±.025 inch for resistance values less than 10Ω.

FIGURE 308-2. Fixed resistors, precision.



Inches	mm	Inches	mm
.002	0.05	.125	3.18
.025	0.64	.250	6.35
.031	0.79	.325	8.26
.046	1.17	.500	12.70
.0625	1.588	1.500	38.10
.102	2.59		

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The end of the body shall be that point at which the body diameter equals the nearest drill size larger than 250 percent of the nominal lead diameter.
4. Maximum length is "clean lead to clean lead".
5. Resistance measuring point shall be .5 ±.125 inch for resistance values of 10Ω or more and .0625 ±.025 inch for resistance values less than 10Ω.

FIGURE 308-3. Fixed resistors, precision.

SECTION 400

RESISTORS, VARIABLE, ESTABLISHED RELIABILITY

400 (CONTENTS)

SECTION 401

RESISTORS, VARIABLE, WIREWOUND (LEAD SCREW ACTUATED),

ESTABLISHED RELIABILITY

STYLES RTR12, RTR22, AND RTR24

(APPLICABLE SPECIFICATION: MIL-R-39015)

1. SCOPE. This section covers established reliability, lead-screw actuated, wirewound, variable resistors with a contact which bears uniformly over the surface of a linearly-wound resistive element, when positioned by a multiturn lead-screw actuator. These resistors are capable of full-load operation (when maximum resistance is engaged) at a maximum ambient temperature of 85°C and are suitable for continuous operation, when properly derated, at a maximum temperature of 150°C. The resistance tolerance of these resistors is ±5.0 percent. These resistors possess life failure rate levels ranging from 1.0 to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level and maintained at a 10-percent producer's risk on the basis of life tests. The failure rate level refers to operation at full rated voltage at 85°C, with a permissible change in resistance of ±3.0 percent plus the specified resolution as the criteria for failure.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have an element of continuous-length wire, wound linearly on a rectangular or arc-shaped core, depending upon the style. The sliding contact traverses the element in a circular or straight line, again dependent upon style. The element is protected from detrimental environmental conditions by a housing or enclosure. The lead screw head is insulated from the electrical portion of the resistor. Due to the reliability requirements of MIL-R-39015, processes and controls utilized in manufacturing are necessarily stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of these requirements.

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 85°C when mounted on a 1/16-inch thick, glass base, epoxy laminate. Therefore the heat sink effect as provided by steel test plates in other specifications is not present. The wattage rating is applicable when the entire resistance element is engaged in the circuit. When only a portion is engaged, the wattage is reduced directly in the same proportion as the resistance.

2.1.3 Power rating. These resistors have a power rating based on full-load operation at 85°C (when the maximum resistance is engaged). When the resistor is to be used in a circuit where the surrounding temperature is higher than 85°C, the wattage must be reduced so as not to overload the resistor. (See figure 401-1.)

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating with optimum performance.

2.1.5 High resistances and voltages. Where voltages higher than 250 volts rms are present between the resistor circuit and grounded surface on which the resistor is mounted, or where the dc resistance is so high that the insulation resistance to ground is an important factor, secondary insulation to withstand the conditions should be provided between the resistor and mounting or between the mounting and ground.

2.2 Mounting of resistors. Resistors with terminal type L should not be mounted by their flexible-wire leads. Mounting hardware should be used. Printed-circuit types are frequently terminal mounted, although brackets may be necessary for a high-shock and vibration environment.

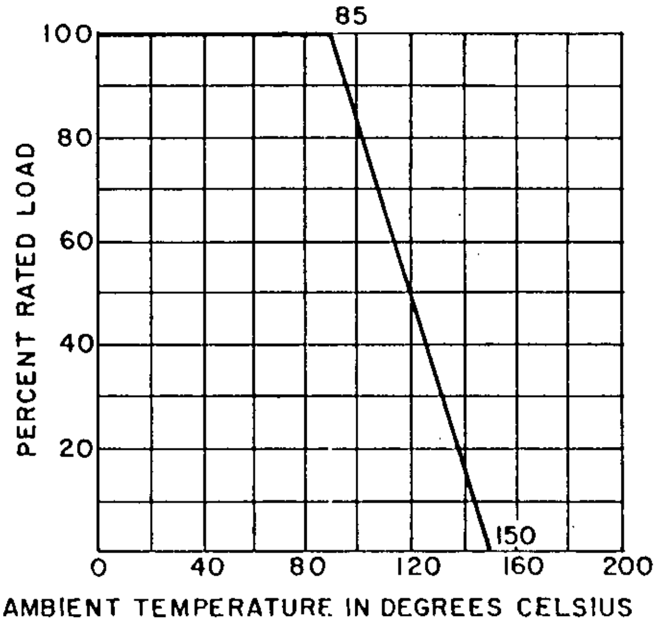


FIGURE 401-1. Derating curve for high-ambient temperature.

2.3 Stacking of resistors. When stacking resistors, care should be taken to compensate for the added rise in temperature by derating the wattage rating accordingly.

2.4 Resistance-temperature characteristic. Consideration should be given to temperature rise and ambient temperature of resistors under operation in order to allow for the change in resistance due to resistance-temperature characteristic. The resistance-temperature characteristic is measured between the two end terminals. Whenever resistance-temperature characteristic is critical, variation due to the resistance of the movable contact should be considered.

2.5 Noise. The noise level is low compared to non-wirewound types. Peak noise is specification controlled at an initial value of 100 ohms maximum. However, after exposure to environmental tests (moisture, shock, vibration, etc.,), a degradation to 500 ohms is allowed by specification.

2.6 Resistive element wire size. Use of wire size of less than .001 inch diameter is not recommended for new design.

2.7 Terminals. Terminal types P, W, X, and Y are considered to be solderable only. If weldable leads are required, they must be separately specified in the contract or purchase order.

2.8 Screening requirements. All resistors furnished under MIL-R-39015 are subjected to a 50-hour conditioning life test by cycling at 1 watt at 25°C followed by peak noise and total resistance measurements and a seal test for detection of leaks.

2.9 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±3 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

3. ITEM IDENTIFICATION (see figures 401-2 through 401-4).

3.1 Part number. The part number is used for identifying the resistor as shown on figure 401-2.

M39015/1- 001 P M

SPECIFICATION NUMBER: The number identifies the detail specification number (indicating MIL-R-39015/1).

DASH NUMBER: The applicable dash number is as indicated in figure 401-4 and corresponds to the type designation as per figure 401-3.

TERMINALS:* The single-letter symbol identifies the terminals as follows:

L - - - Flex, insulated wire leads
P - - - Printed circuit pins (base mount)
W - - - Printed circuit pins (edge mount)
X - - - Printed circuit pins (edge mount) (alternate configuration)
Y - - - Printed circuit pins (staggered) (RTR12 only)

LIFE FAILURE RATE: The single-letter symbol identifies the life failure rate level as follows:

M - - - 1.0 percent/1,000 hr
P - - - 0.1 percent/1,000 hr
* R - - - 0.01 percent/1,000 hr

*See figure 401-4 for terminal availability for each style.

FIGURE 401-2. Part number example.

3.2 Type designation. The type designation is used for describing the resistor as shown on figure 401-3.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 401-I.

3.3 Preferred nominal total resistance values. The preferred nominal total resistance values, maximum resolutions, and the applicable rated working voltage are as follows:

Nominal total resistance	Max resolution (percent)			Rated working voltage (ac or dc)
Ohms	RTR12	RTR22	RTR24	Volts
10	2.2	1.3	1.3	2.7
20	2.0	1.0	1.1	3.8
50	1.3	.80	.77	6.1
100	1.1	.51	.62	8.7
200	0.9	.42	.55	12.3
500	0.6	.42	.51	19.4
1,000	0.5	.36	.37	27.4
2,000	0.4	.29	.30	38.7
5,000	0.3	.26	.25	61.3
*10,000	0.3	.14	---	86.7

*Value based on the use of .001-inch nominal (.0009 absolute) minimum diameter wire (styles RTR12 and RTR22).

RTR12 D Y 102 M

STYLE: The three-letter symbol "RTR" identifies established reliability, lead-screw actuated, wire-wound, variable resistors; the two-digit number identifies the physical size.

CHARACTERISTIC: The single-letter symbol "D" identifies the resistance-temperature characteristic of ±50 ppm/°C; maximum ambient temperature of 85°C at rated wattage, and maximum ambient operating temperature of 150°C at zero load.

TERMINALS:* The single-letter symbol identifies the terminals as follows:

L - - - Flex, insulated wire leads
P - - - Printed circuit pins (base mount)
W - - - Printed circuit pins (edge mount)
X - - - Printed circuit pins (edge mount) (alternate configuration)
Y - - - Printed circuit pins (staggered) (RTR12 only)

RESISTANCE: The three-digit number identifies the nominal total resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:

101	100 ohms
201	200 ohms
102	1,000 ohms
202	2,000 ohms

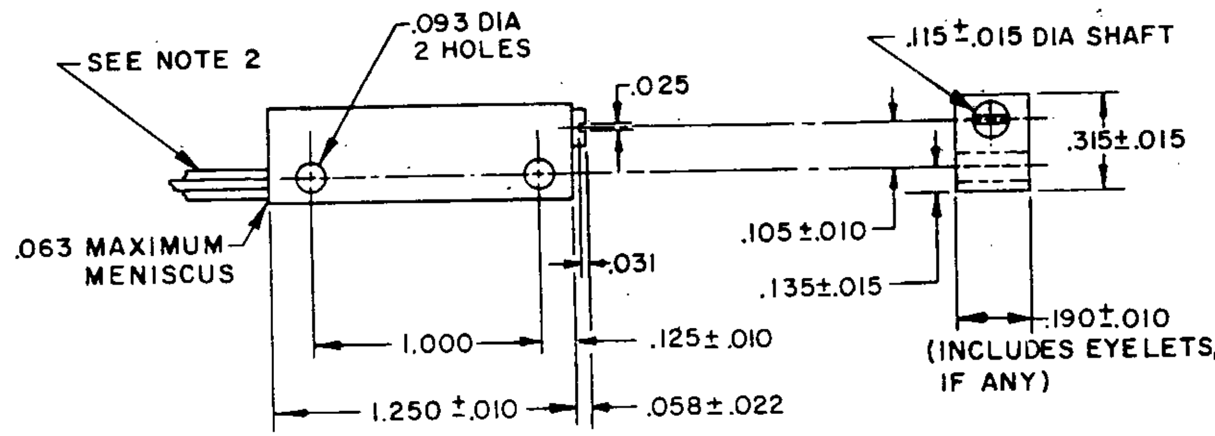
LIFE FAILURE RATE: The single-letter symbol identifies the life failure rate level as follows:

M - - - 1.0 percent/1,000 hr
P - - - 0.1 percent/1,000 hr
R - - - 0.01 percent/1,000 hr

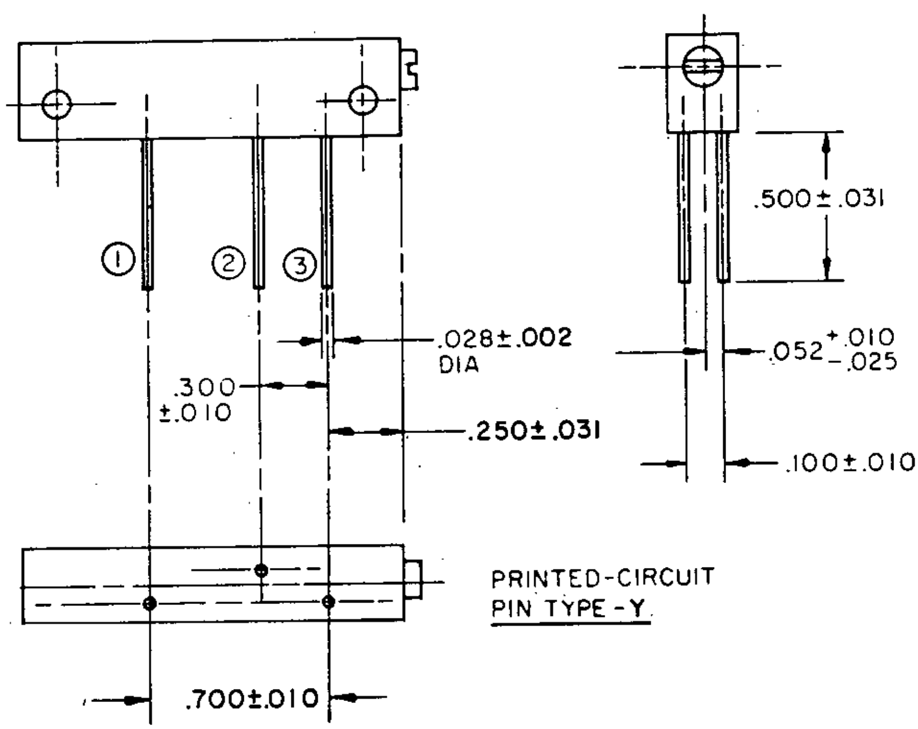
*See figure 401-4 for terminal availability for each style.

FIGURE 401-3. Type designation example.

STYLE RTR12



FLEXIBLE LEAD TERMINAL TYPE – L

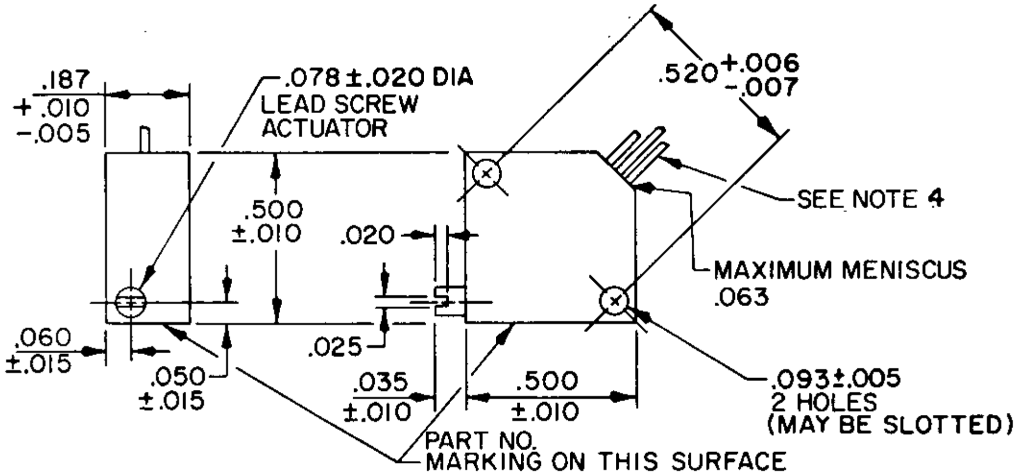


Inches	mm
.002	.05
.010	.25
.015	.38
.022	.56
.025	.64
.028	.71
.031	.79
.052	1.32
.058	1.47
.063	1.60
.093	2.36
.100	2.54
.105	2.67
.115	2.92
.125	3.18
.135	3.43
.190	4.83
.250	6.35
.300	7.62
.315	8.00
.500	12.70
.700	17.78
1.000	25.40
1.250	31.75

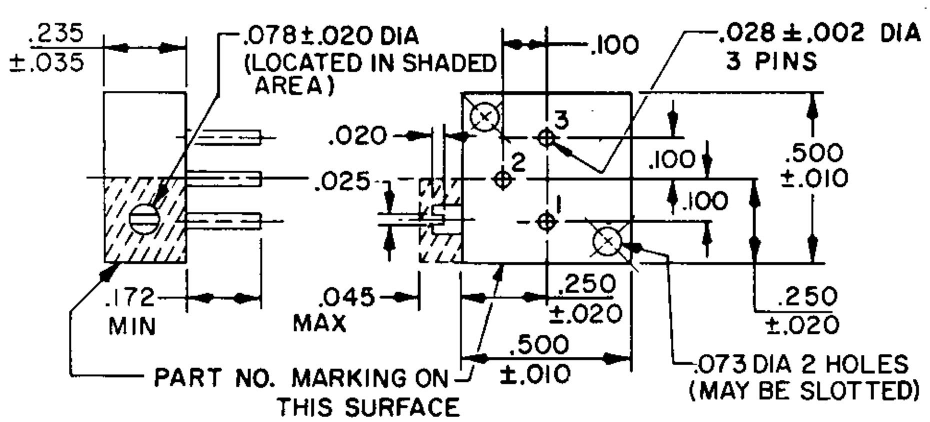
NOTES:
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The three leads are stranded wire, AWG size 28 to 30, 6.00 (152.40 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped approximately .250 ±.002 (6.35 ±.05 mm) from the end, and color coded.

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors.

STYLE RTR22



TERMINAL TYPE L

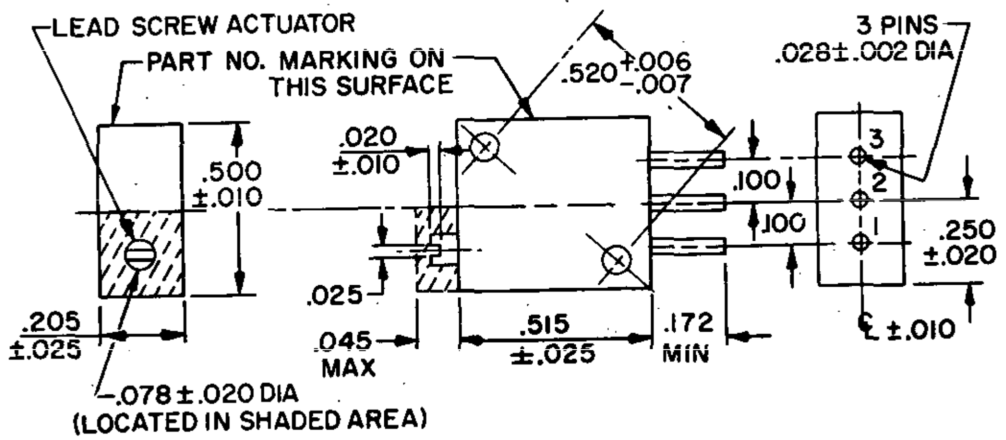


TERMINAL TYPE P

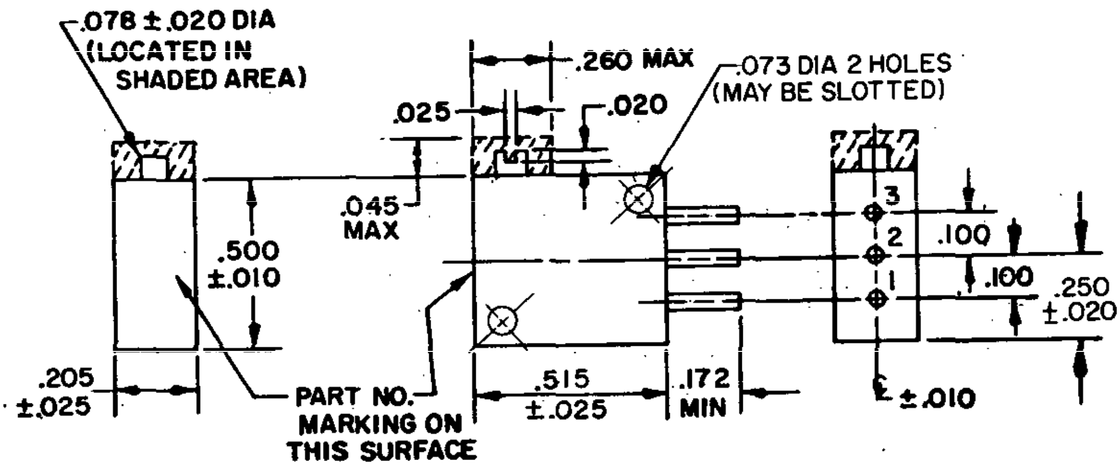
Inches	mm	Inches	mm	Inches	mm
.002	.05	.028	.71	.172	4.37
.003	.08	.035	.89	.187	4.75
.005	.13	.045	1.14	.205	5.21
.006	.15	.050	1.27	.235	5.97
.007	.18	.060	1.52	.250	6.35
.010	.25	.073	1.85	.260	6.60
.015	.38	.078	1.98	.500	12.70
.020	.51	.093	2.36	.515	13.08
.025	.64	.100	2.54	.520	13.21

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

STYLE RTR22 - Continued



TERMINAL TYPE W

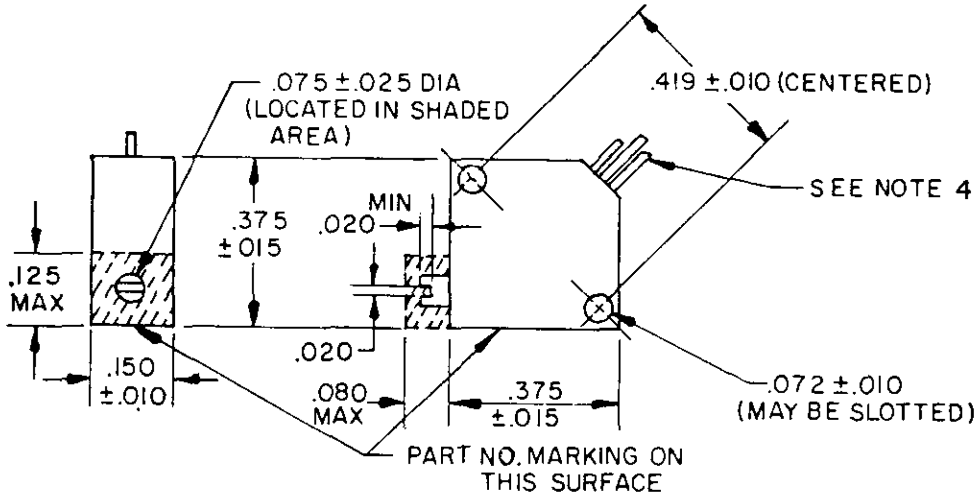


TERMINAL TYPE X

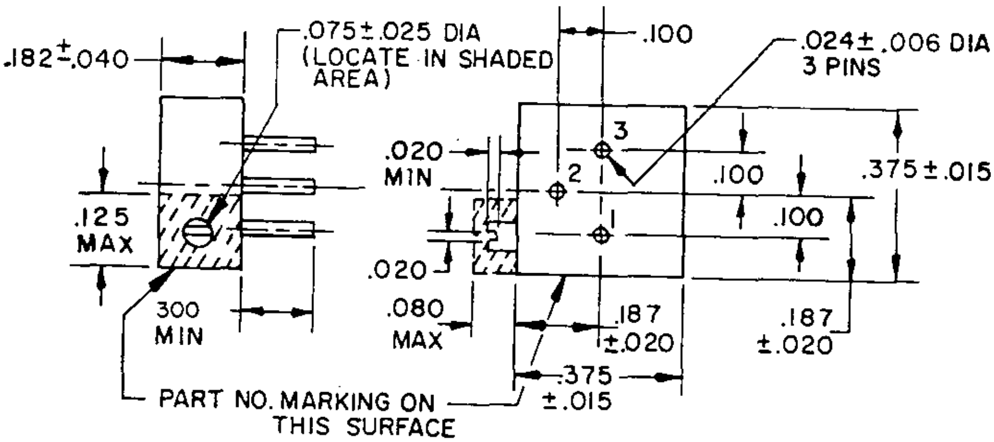
NOTES:
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The entire slot of the actuating screw is above the surface of the unit.
3. For types P, W, and X, normal mounting means is by use of pins only.
4. The three leads are stranded wire, AWG size 28 to 30, 6.00 (152.40 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped approximately .250 (6.35 mm) ±.062 (1.57 mm) from the end, and color coded.
5. Dimensions not shown are the same as type L.

FIGURE 401-4. Established reliability, lead screw actuated wirewound, variable resistors - Continued.

STYLE RTR24



TERMINAL TYPE L

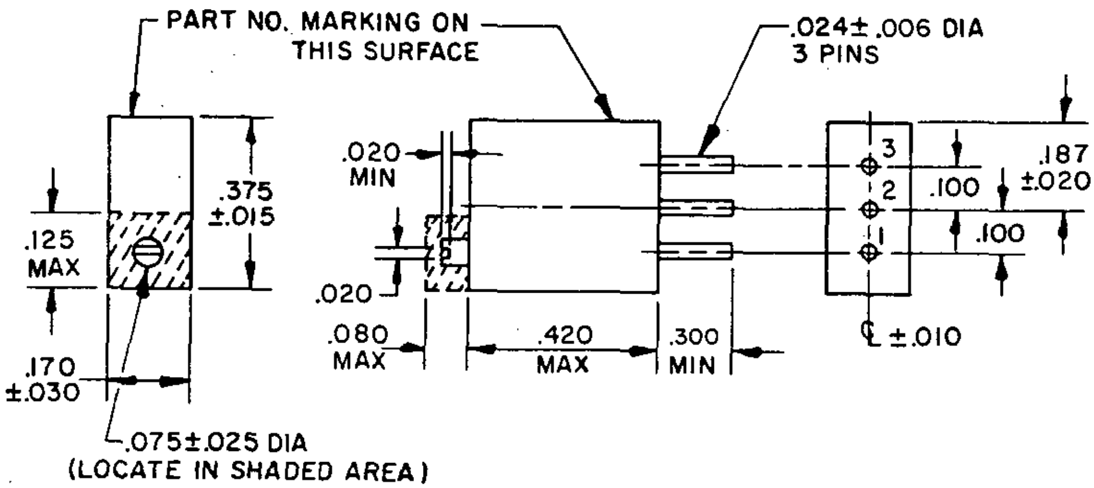


TERMINAL TYPE P

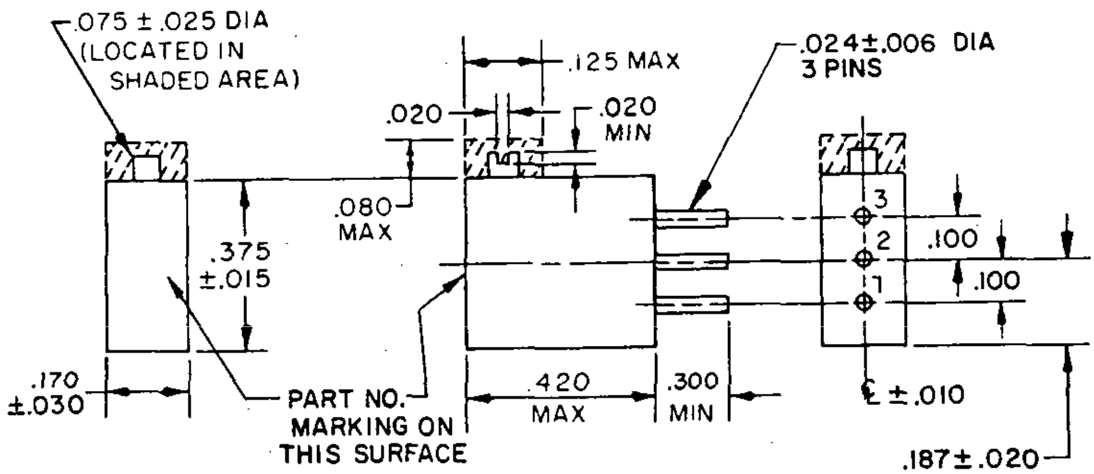
Inches	mm	Inches	mm	Inches	mm
.006	.15	.038	.97	.170	4.32
.009	.23	.040	1.02	.182	4.62
.010	.25	.072	1.83	.184	4.67
.015	.38	.075	1.91	.187	4.75
.020	.51	.080	2.03	.300	7.62
.024	.61	.100	2.54	.375	9.53
.025	.64	.125	3.18	.419	10.64
.035	.75	.150	3.81	.420	10.67

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

STYLE RTR24 - Continued



TERMINAL TYPE W



TERMINAL TYPE X

NOTES:
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The entire slot of the actuating screw is above the surface of the unit.
3. The picturization of the styles above are given as representative of the envelope of the item. Slight deviations from the outline shown, which are contained within the envelope, and do not alter the functional aspects of the device are acceptable.
4. The three leads are stranded wire, AWG size 28 to 30, 6.00 (152.4 mm) minimum length; they are insulated with polytetrafluoroethylene stripped .250 ±.062 (6.35 ±1.57 mm) from the end, and color coded.
5. Maximum weight is 1.3 grams.

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

Nominal resistance value 1/	Maximum rated ac and dc working voltage	Part number 2/			Type designation 2/ (for information only)		
		M39015/1-	M39015/2-	M39015/3-	RTR12D-	RTR22D-	RTR24D-
Ohms	Volts	RTR12	RTR22	RTR24			
10	2.7	009--	009--	001--	100-	100-	100-
20	3.8	010--	010--	002--	200-	200-	200-
50	6.1	011--	011--	003--	500-	500-	500-
100	8.7	001--	001--	004--	101-	101-	101-
200	12.3	002--	002--	005--	201-	201-	201-
500	19.4	003--	003--	006--	501-	501-	501-
1,000	27.4	004--	004--	007--	102-	102-	102-
2,000	38.7	005--	005--	008--	202-	202-	202-
5,000 3/	61.3	006--	006--	009--	502-	502-	502-
10,000 4/	86.7	007--	007--	---	103-	103-	---

1/ For Navy use (styles RTR12 and RTR22), resistance values are based on the use of wire having no less than 0.001-inch nominal (0.0009 absolute) diameter.

2/ Complete part number (and type designation) includes additional symbols to indicate terminal type and failure rate level (see figures 401-2 and 401-3).

3/ For style RTR24, value based on use of wire having no less than 0.001-inch ±10 percent diameter.

4/ For RTR12 and RTR22, value based on the use of wire having no less than 0.001-inch nominal (0.0009 absolute) diameter.

NOTE: MIL-R-39015/1, /2, and /3 resistors, regardless of their failure rate designation, are substitutes for resistors of the same resistance value, tolerance, terminal characteristic, and resistance temperature characteristic specified in MIL-R-27208/8, /4, and /9, respectively.

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

TABLE 401-I. Performance characteristics.

Features	Style RTR12	RTR22	RTR24
Max resistance temperature characteristic in ppm/°C (Ref to 25°C)	±50	±50	±50
Max ambient temperature at rated wattage (see figure 401-1)	85°C	85°C	85°C
Max ambient temperature at zero wattage derating (see figure 401-1)	150°C	150°C	150°C
Min nominal total resistance (ohms)	10	10	10
Max nominal total resistance (ohms)	10 kΩ	10 kΩ	5 kΩ
Power rating (watts)	3/4	3/4	3/4
Max percent change in resistance (±): 1/			
Conditioning	0.5	0.5	0.5
Thermal shock	1.0	1.0	1.0
Moisture resistance	1.0	1.0	1.0
Shock (specified pulse)	1.0	1.0	1.0
Vibration, high frequency	1.0	1.0	1.0
Resistance to soldering heat	1.0	1.0	1.0
Low temperature operation	1.0	1.0	1.0
Low temperature storage	1.0	1.0	1.0
High temperature exposure	1.0	1.0	1.0
Rotational life (200 cycles)	2.0	2.0	2.0
Life:			
Qualification (2,000 hr cont. to 10,000)	2.0	2.0	2.0
Failure rate determination (10,000 hr)	3.0	3.0	3.0
Resistance tolerance	±5 percent	±5 percent	±5 percent
Insulation resistance (megohms):			
Dry	1,000	1,000	1,000
Wet (after moisture resistance)	100	100	100
Peak noise (ohms)	≤500	≤500	≤500
Salt spray	No visible corrosion	Same as RTR12	Same as RTR12
Resistance to solvents	Remain legible	Same as RTR12	Same as RTR12
Immersion	No more than 3 bubbles	Same as RTR12	Same as RTR12
Actual effective-electrical travel (turns)	17 min 27 max	20 min 42 max	15 min 30 max
Dielectric withstanding voltage (volts rms):			
Atmospheric pressure, sea level	900	900	900
Reduced barometric pressure, 70,000 ft	350	350	350
Operating torque (inch-ounce):			
Max	5.0	8.0	5.0
Min	0.1	0.1	---

1/ Where total resistance change is 1 percent or less, it shall be considered as ±(percent +0.05 ohm) for values below 100 ohms.

SECTION 402

RESISTORS, VARIABLE, NON-WIREWOUND (ADJUSTMENT TYPE), ESTABLISHED RELIABILITY

STYLES RJR12, RJR24, RJR26, RJR28, AND RJR50

(APPLICABLE SPECIFICATION: MIL-R-39035)

1. SCOPE. This section covers established reliability, adjustment type, non-wirewound, variable resistors with a contact which bears uniformly over the surface of a non-wirewound resistive element, when positioned by a multiturn lead-screw actuator. These resistors are capable of full-load operation (when maximum resistance is engaged) at a maximum ambient temperature of 85°C and are suitable for continuous operation, when properly derated, at a maximum temperature of 150°C. The resistance tolerance of these resistors is ±10 percent. These resistors possess life failure rate levels ranging from 1.0 to 0.001 percent per 1,000 hours. The failure rates are established at a 60-percent confidence level and maintained at a 10-percent producer's risk on the basis of life tests. The failure rate level refers to operation at full rated voltage at 85°C, with a permissible change in resistance of ±10 percent as criteria for failure.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. These resistors have an element of continuous resistive material (cermet, metal film, etc.,) on a rectangular or arc-shaped core, depending upon the style. The sliding contact traverses the element in a circular or straight line again dependent upon style. The element is protected from detrimental environmental conditions by a housing or enclosure. The lead-screw head is insulated from the electrical portion of the resistor. Due to the reliability requirements of MIL-R-39035, processes and controls utilized in manufacturing are necessarily stringent. MIL-STD-790, "Reliability Assurance Program for Electronic Parts Specifications," provides for monitoring and documentation of these requirements.

2.1.2 Selection of a safe resistor style. The wattage ratings of these resistors are based on operation at 85°C when mounted on a 1/16-inch thick, glass base, epoxy laminate. Therefore the heat sink effect as provided by steel test plates in other specifications is not present. The wattage rating is applicable when the entire resistance element is engaged in the circuit. When only a portion is engaged, the wattage is reduced directly in the same proportion as the resistance.

2.1.3 Power rating. These resistors have a power rating based on full-load operation at 85°C (when the maximum resistance is engaged). When the resistor is to be used in a circuit where the surrounding temperature is higher than 85°C, the wattage must be reduced so as not to overload the resistor. (See figure 402-1.)

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of 2 applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating with optimum performance.

2.1.5 High resistances and voltages. Where voltages higher than 250 volts rms are present between the resistor circuit and grounded surface on which the resistor is mounted, or where the dc resistance is so high that the insulation resistance to ground is an important factor, secondary insulation to withstand the conditions should be provided between the resistor and mounting or between the mounting and ground.

2.2 Mounting of resistors. Resistors with terminal type L should not be mounted by their flexible wire leads. Mounting hardware should be used. Printed-circuit types are frequently terminal mounted, although brackets may be necessary for a high-shock and vibration environment.

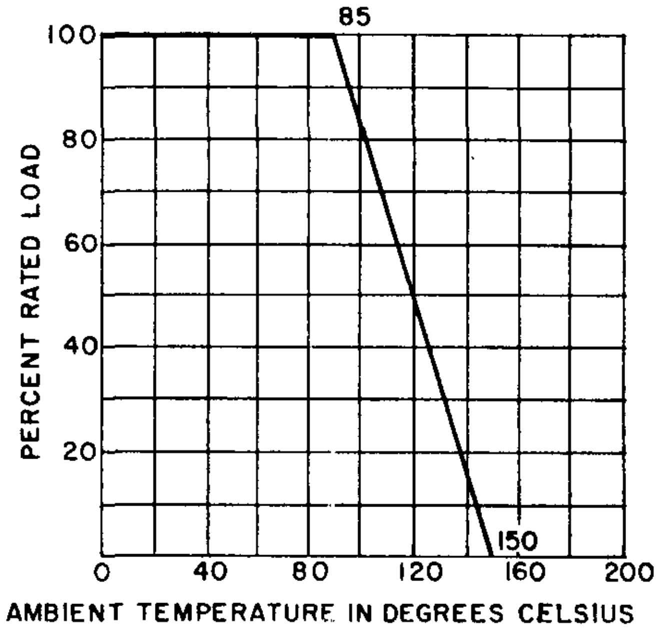


FIGURE 402-1. Derating curve for high-ambient temperature.

2.3 Stacking of resistors. When stacking resistors, care should be taken to compensate for the added rise in temperature by derating the wattage rating accordingly.

2.4 Resistance-temperature characteristic. Consideration should be given to temperature rise and ambient temperature of resistors under operation in order to allow for the change in resistance due to resistance-temperature characteristic. The resistance-temperature characteristic is measured between the two end terminals. Whenever resistance-temperature characteristic is critical, variation due to the resistance of the movable contact should be considered.

2.5 Contact-resistance variation. The contact resistance variation shall not exceed 3 percent or 20 ohms for characteristic C, and 3 percent or 3 ohms for characteristics F and H, whichever is greater.

2.6 Terminals. Terminal types P, W, X, and Y are considered solderable only. If weldable leads are required, they must be separately specified in the contact or purchase order.

2.7 Screening requirements. All resistors furnished under MIL-R-39035 are subjected to a 50-hour conditioning life test by cycling at 3/4 watt at 25°C followed by contact resistance variation and total resistance measurements and a seal test for detection of leaks.

2.8 Failure rate factors. Failures are considered to be opens, shorts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short a period of time to permit detection through normal preventive maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217 (see MIL-R-22097 data). The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rate is based on a "parametric failure" of ±5 percent change in resistance to be expected at 0 to 10,000 hours of life tests at rated conditions.

3. ITEM IDENTIFICATION (see figures 402-2 and 402-3).

3.1 Type designation. The type designation is used for describing the resistor as shown on figure 402-2.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 402-I.

3.3 Preferred nominal total resistance values. The preferred nominal total resistance values and the applicable maximum rated working voltages are as follows:

Nominal resistance value	Maximum rated ac or dc working voltage per characteristic C, F, and H				F
	RJR12	RJR24	RJR26	RJR28	RJR50
Ohms					
10	2.7	2.23	---	1.73	1.58
20	3.8	3.1	---	2.45	2.23
50	6.1	5.0	3.54	3.88	3.54
100	8.7	7.0	5.0	5.48	5.0
200	12.3	10.0	7.07	7.75	7.07
500	19.4	15.8	11.1	12.2	11.1
1,000	27.4	22.3	15.8	17.3	15.8
2,000	38.7	31.6	22.3	24.5	22.3
5,000	61.3	50.0	35.4	38.8	35.4
10,000	86.7	70.7	50.0	54.8	50.0
20,000	122.0	100.0	70.7	77.5	70.7
25,000	136.0	111.0	79.0	86.6	79.0
50,000	194.0	158.0	111.0	122.5	111.0
Megohms					
0.10	274	223	158	173	158
0.25	300	300	200	274	200
0.50	300	300	200	300	200
1.0	300	300	200	300	---
2.0	---	---	---	300	---

RJR24 C L 102 M

STYLE: The three-letter symbol "RJR" identifies established reliability, adjustment type, non-wire-wound, variable resistors; the two-digit number identifies the physical size.

CHARACTERISTIC: The single-letter symbol identifies the resistance-temperature characteristic (at 85°C maximum ambient temperature at rated wattage, and 150°C maximum ambient operating temperature at zero load) as follows:

C - - - ±250 ppm/°C
F - - - ±100 ppm/°C
H - - - ±50 ppm/°C

TERMINALS:* The single-letter symbol identifies the terminals as follows:

L - - - Flex, insulated wire leads
P - - - Printed circuit pins (base mount)
W - - - Printed circuit pins (edge mount)
X - - - Printed circuit pins (edge mount) (alternate configuration)
Y - - - Printed circuit pins (staggered) (RJR12 only)

RESISTANCE: The three-digit number identifies the nominal total resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:

101	100 ohms
201	200 ohms
102	1,000 ohms
202	2,000 ohms

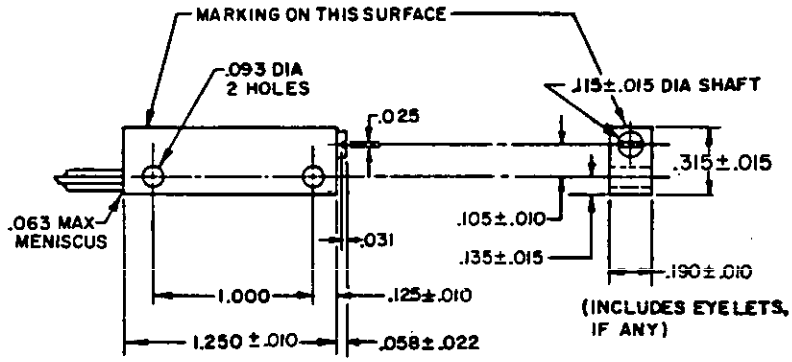
LIFE FAILURE RATE: The single-letter symbol identifies the life failure rate level as follows:

M - - - 1.0 percent/1,000 hr
P - - - 0.1 percent/1,000 hr
* R - - - 0.01 percent/1,000 hr

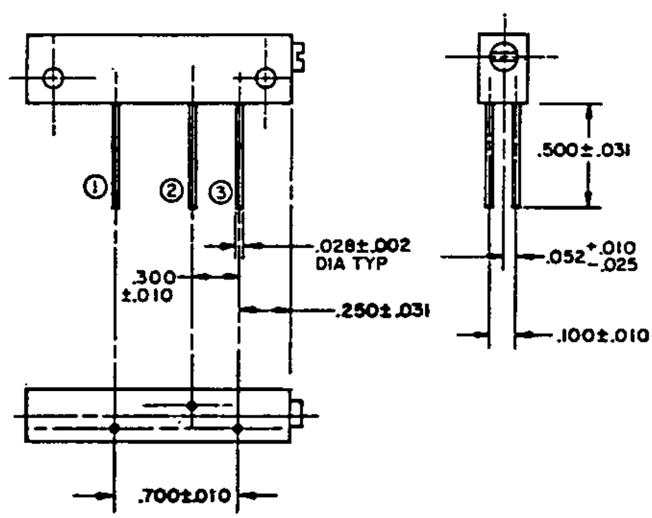
*See figure 402-3 for terminal availability for each style.

FIGURE 402-2. Type designation example.

STYLE RJR12



FLEXIBLE LEAD TERMINAL TYPE - L



PRINTED-CIRCUIT
PIN TERMINAL TYPE - Y

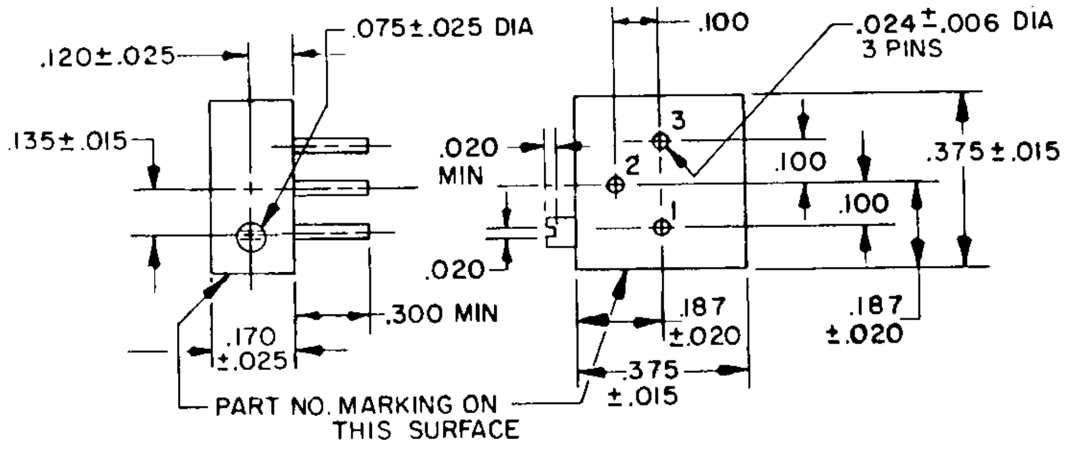
Inches	mm
.002	.05
.003	.08
.005	.13
.010	.25
.015	.38
.022	.56
.025	.64
.028	.71
.031	.79
.052	1.32
.058	1.47
.063	1.60
.093	2.36
.100	2.54
.105	2.67
.115	2.92
.125	3.18
.135	3.43
.190	4.83
.250	6.35
.260	6.60
.300	7.62
.315	8.00
.500	12.70
.700	17.78
.900	22.86
1.000	25.40
1.250	31.75

NOTES:

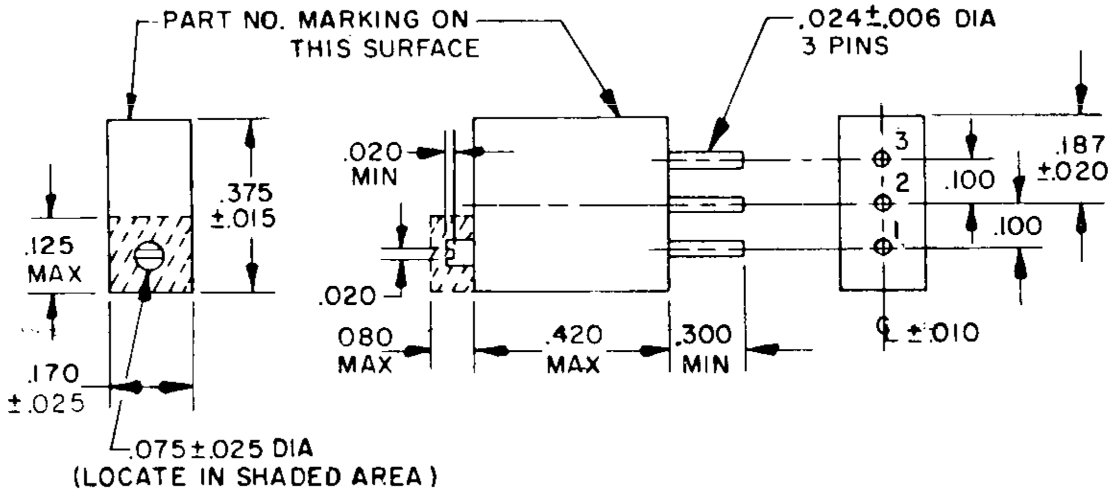
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The three leads are of stranded wire, AWG size 28 to 30, 6.00 (152.4 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped .250 ±.062 (6.35 ±1.57 mm) from the end and color coded.
3. The picturization of the style above is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors.

STYLE RJR24



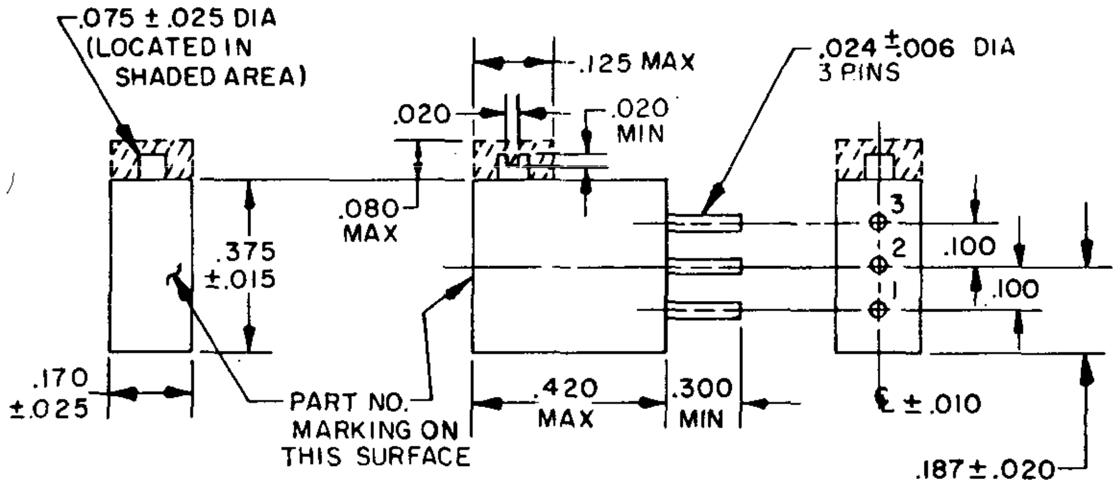
TERMINAL TYPE P



TERMINAL TYPE W

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors - Continued.

STYLE RJR24 - Continued



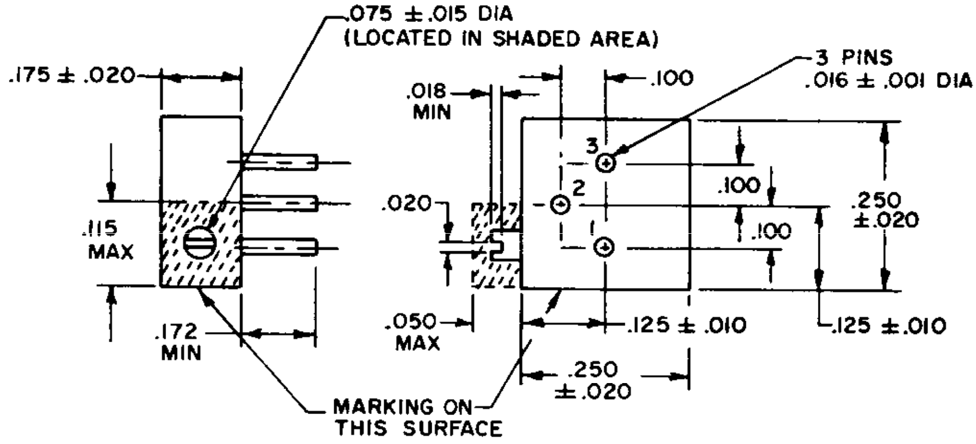
TERMINAL TYPE X

Inches	mm	Inches	mm
.002	.05	.105	2.67
.006	.15	.120	3.05
.010	.25	.125	3.18
.015	.38	.135	3.43
.020	.51	.170	4.32
.024	.61	.172	4.37
.025	.64	.187	4.75
.072	1.83	.300	7.62
.075	1.91	.375	9.53
.080	2.03	.419	10.64
.100	2.54	.420	10.67

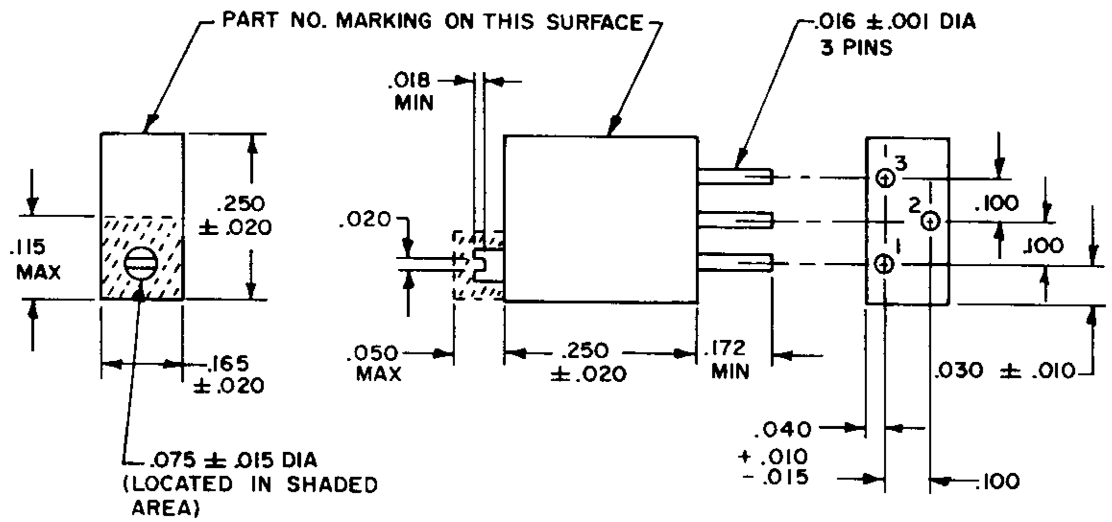
NOTES:
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The entire slot of the actuating screw is above the surface of the unit.
3. For types P, W, and X, normal mounting means is by use of pin only.
4. The three leads are of stranded wire, AWG size 28 to 30, 6.00 (152.4 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped .250 ±.062 (6.35 ±1.57 mm) from the end and color coded.
5. The picturization of the style above is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors - Continued.

STYLE RJR26



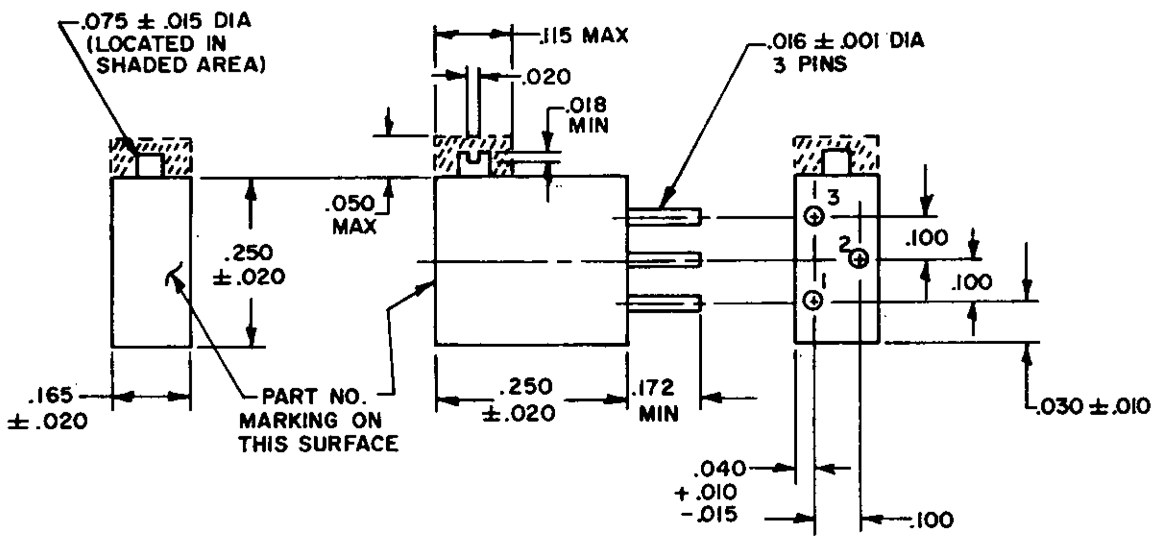
TERMINAL TYPE P



TERMINAL TYPE W

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors - Continued.

STYLE RJR26 - Continued.



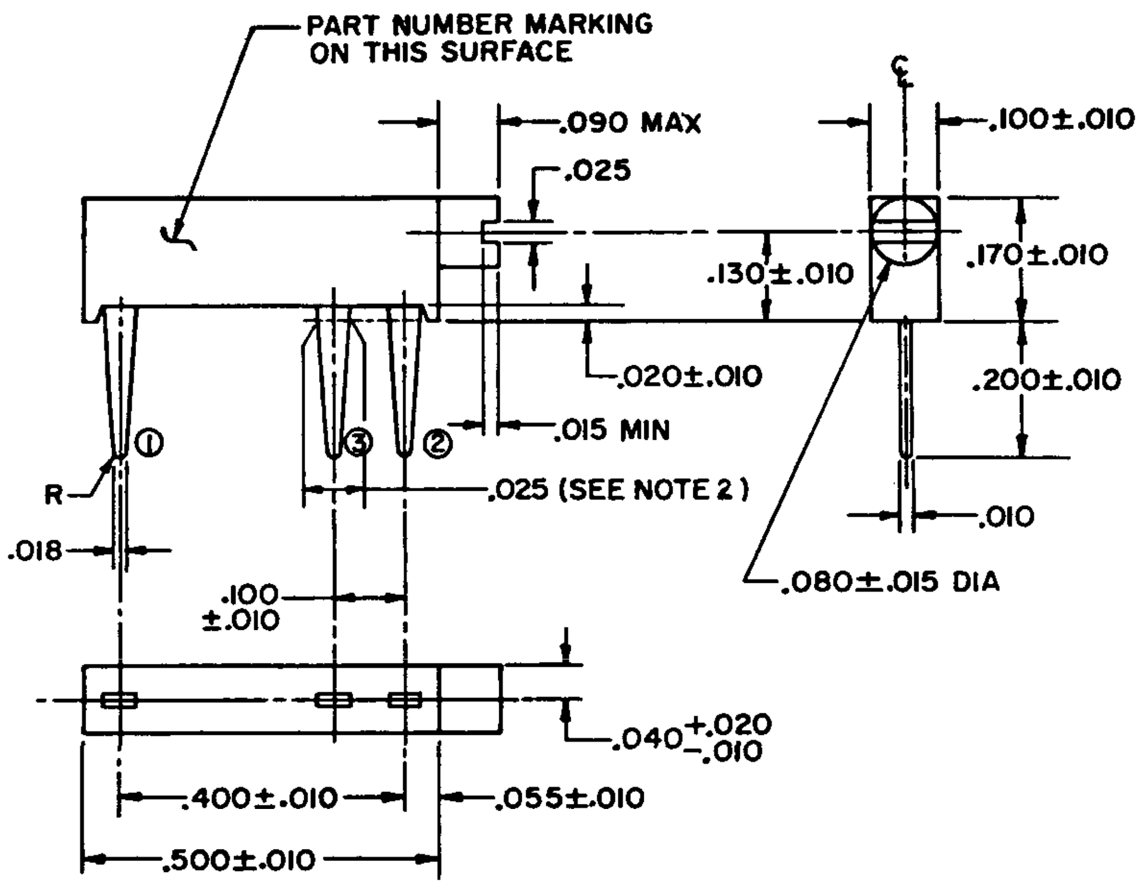
TERMINAL TYPE X

Inches	mm
.001	.03
.010	.25
.015	.38
.016	.41
.018	.46
.020	.51
.030	.76
.040	1.02
.050	1.27
.075	1.90
.100	2.54
.115	2.92
.125	3.18
.165	4.19
.172	4.37
.175	4.44
.250	6.35

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.005 (0.13 mm).
4. The entire slot of the actuating screw must be above the surface of the unit.
5. The head of the lead screw actuator shall not extend beyond any edge of the surface upon which it is mounted.
6. Mounting means are by use of pins only.

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors - Continued.

STYLE RJR28



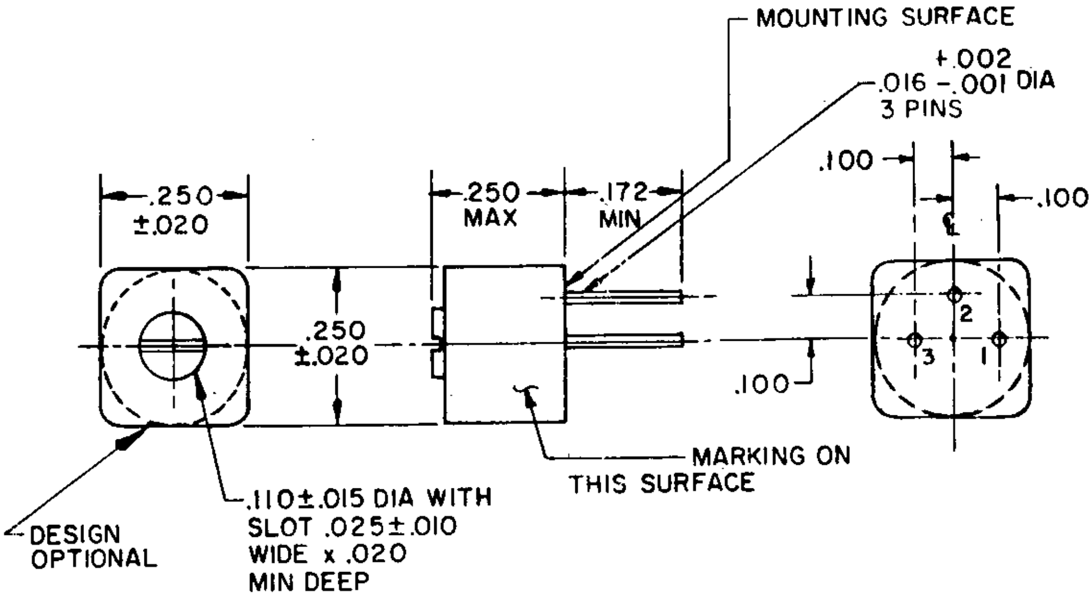
TERMINAL TYPE P

Inches	mm	Inches	mm
.010	.25	.090	2.29
.015	.38	.100	2.54
.018	.46	.130	3.30
.020	.51	.170	4.32
.025	.64	.200	5.08
.040	1.02	.400	10.16
.055	1.40	.500	12.70

NOTES:
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. Terminal width is .025 (.64 mm) at mounting surface.
3. The picturization of the style above is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors - Continued.

STYLE RJR50



TERMINAL TYPE P

Inches	mm
.001	.03
.002	.05
.010	.25
.015	.38
.016	.41
.020	.51
.025	.64
.100	2.54
.110	2.79
.172	4.37
.250	6.35

NOTES:
1. Unless otherwise specified, tolerances are ±.005 (.13 mm) and +0°30'.
2. Mounting means are by use of pins only.
3. The head of the actuating screw may or may not be flush with or recessed in the body.
4. The picturization of the style above is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.

FIGURE 402-3. Established reliability, adjustment type, non-wirewound, variable resistors - Continued.

TABLE 402-I. Performance characteristics.

Features	Style				
	RJR12	RJR24	RJR26	RJR28	RJR50
Max resistance temperature characteristic in ppm/°C (Ref to 25°C)	±100, ±250	±50, ±100, ±250	±50, ±100	±100, ±250	±100
Max ambient temperature at rated wattage (see figure 402-1)	85°C	85°C	85°C	85°C	85°C
Max ambient temperature at zero wattage derating (see figure 402-1)	150°C	150°C	150°C	150°C	150°C
Min nominal total resistance (ohms)	10	10	50	100	10
Max nominal total resistance (megohms)	1.0	1.0	1.0	2.0	1.0
Power rating (watts)	3/4	1/2	1/4	0.3	1/4
Max percent change in resistance (±): 1/					
Conditioning	1.5 to 2.0	1.5 to 2.0	1.5	1.5 to 2.0	1.5
Thermal shock	1.0 to 2.0	1.0 to 2.0	1.0	1.0 to 2.0	1.0
Moisture resistance	1.0 to 2.0	1.0 to 2.0	1.0	1.0 to 2.0	1.0
Shock (specified pulse)	1.0	1.0	1.0	1.0	1.0
Vibration, high frequency	1.0	1.0	1.0	1.0	1.0
Resistance to soldering heat	1.0	1.0	1.0	1.0	1.0
Low temperature operation	1.0 to 2.0	1.0 to 2.0	1.0	1.0 to 2.0	1.0
Low temperature storage	1.0 to 2.0	1.0 to 2.0	1.0	1.0 to 2.0	1.0
High temperature exposure	3.0	3.0	3.0	3.0	3.0
Rotational life (200 cycles)	2.0	2.0	2.0	2.0	2.0
Life:					
Qualification (2,000 hr cont. to 10,000)	3.0	3.0	3.0	3.0	3.0
Failure rate determination (10,000 hr)	5.0	5.0	5.0	5.0	5.0
Resistance tolerance	±10 percent	±10 percent	±10 percent	±10 percent	±10 percent
Insulation resistance (megohms):					
Dry	1,000	1,000	1,000	1,000	1,000
Wet (after moisture resistance)	100	100	100	100	100
Max contact resistance variation	3% or 20 ohms (characteristic C) 3% or 3 ohms (characteristic F)	Same as RJR12	Same as RJR12	Same as RJR12	Same as RJR12
Salt spray	No visible corrosion	Same as RJR12	Same as RJR12	Same as RJR12	Same as RJR12

See footnote at end of table.

TABLE 402-I. Performance characteristics - Continued.

Features	Style				
	RJR12	RJR24	RJR26	RJR28	RJR50
Resistance to solvents	Remain legible	Same as RJR12	Same as RJR12	Same as RJR12	Same as RJR12
Seal	3 bubbles max	Same as RJR12	Same as RJR12	Same as RJR12	Same as RJR12
Actual effective-electrical travel (turns)	17 min 27 max	15 min 30 max	10 min 25 max	5 min 15 max	215° min
Dielectric withstanding voltage (volts rms):					
Atmospheric pressure, sea level	900	900	600	900	600
Reduced barometric pressure, 70,000 ft	350	350	250	350	250
Operating torque (inch-ounce):					
Max	8.0	5.0	3.0	2.0	2.0

1/ Where total resistance change is 1 percent or less, it shall be considered as ±(percent ±0.05 ohm) for values below 100 ohms.

SECTION 500

RESISTORS, SPECIAL

SECTION 501

RESISTOR NETWORKS, FIXED, FILM

* STYLES RZ010, RZ020, RZ030, RZ040, RZ050, RZ060, RZ070, RZ080, AND RZ090

(APPLICABLE SPECIFICATION: MIL-R-83401)

1. SCOPE. This section covers fixed resistors in a resistor network configuration having a film resistance element and in a dual-in-line, single-in-line, or flat pack configuration. These resistors are stable with respect to time, temperature, and humidity, and are capable of full load operation at an ambient temperature of 70°C. These resistors are designed for use in critical circuitry where stability, long life, reliable operation, and accuracy are of prime importance. They are particularly desirable for use where miniaturization is important and where ease of assembly is desired. They are useful where a number of resistors of the same resistance value are required in the circuit.

2. APPLICATION INFORMATION.

2.1 Style selection.

2.1.1 Construction. In these resistors the resistance element consists of a film element on a ceramic substrate. The element is formed either by deposition of a vaporized metal or the printing of a metal and glass combination paste which has then been fired at a high temperature. Resistance elements are generally rectangular in shape and calibrated to the proper resistance value by trimming the element by abrasion or a laser beam. After calibration, the resistance element is protected by an enclosure or coating of insulating, moisture-resistant material (usually epoxy or a silicone).

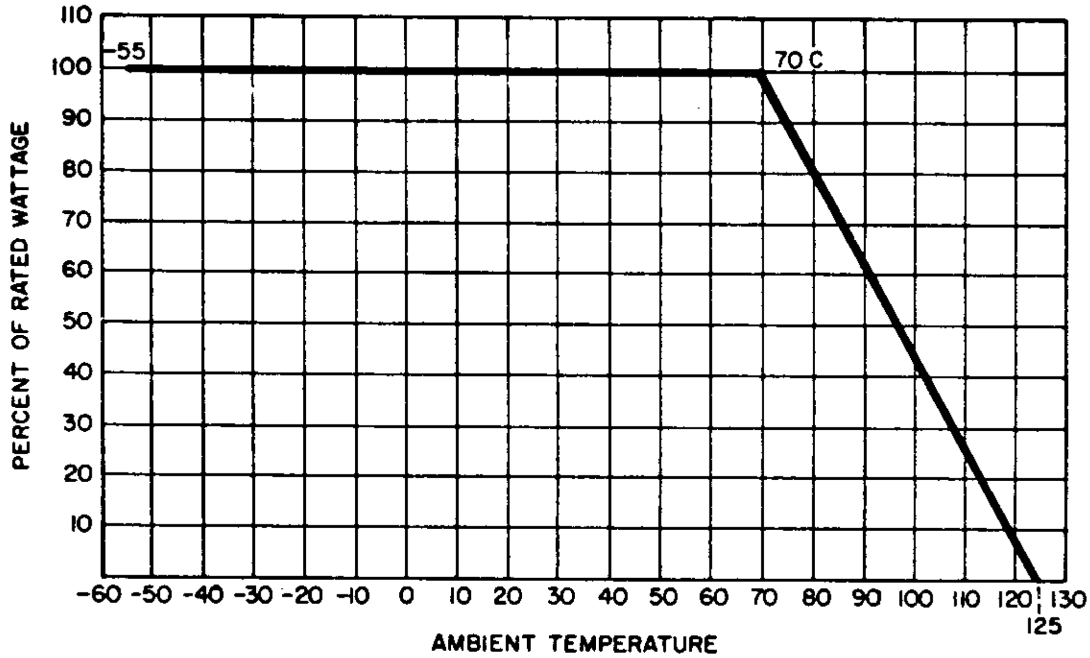
2.1.2 Power rating. These resistors within a network have a power rating based on continuous, full-load operation at an ambient temperature of 70°C. A power rating is given for each resistor within the network and a power rating is given for the total network package. The package power is equal to the individual resistor power rating times the number of resistors within the network. If resistors within the network are to be operated at temperatures exceeding 70°C, the resistors must be derated in accordance with figure 501-1.

2.1.3 Derating for optimum performance. Because all the electrical energy dissipated by a resistor is converted into heat energy, temperature of the surrounding area is an influencing factor when selecting a particular resistor network for a specific application. The power rating of these resistor networks is based on operating at specific temperatures. However, in actual use, a resistor network may not be operating at these temperatures. When a desired characteristic and an anticipated maximum ambient temperature have been determined, a safety factor of 2 applied to the wattage is recommended to insure the selection of a resistor network with an adequate wattage-dissipation potential.

2.2 Resistance tolerance. Designers should bear in mind that operation of these resistor networks under the ambient conditions for which military equipment is designed may cause permanent or temporary changes in resistance sufficient to exceed their initial tolerances. In particular, operation at extremely high or low ambient temperatures may cause significant temporary changes in resistance.

2.3 Voltage limitations. Because of the very small spacing between the resistance elements and the connecting circuits, there are maximum permissible voltages which are imposed. The maximum voltage permissible for each network type is shown in table 501-I.

2.4 Noise. Noise output is not controlled by specification, but for these resistor types, noise is a negligible quantity. In an application where noise is an important factor, resistors in these networks are superior to composition types. Where noise test screening is indicated, it is recommended that MIL-STD-202, method 308, be used.



NOTE: This curve indicates the percentage of nominal wattage to be applied at temperatures higher than 70°C. However, at no time shall the applied voltage exceed the maximum for each style.

FIGURE 501-1. Derating curve for high ambient temperature.

2.5 Moisture resistance. The resistors within the networks are essentially unaffected by moisture. The specification allows only a 0.5 percent change in resistance value as a result of exposure to a standard 10-day moisture resistance test.

2.6 High frequency application. When used in high frequency circuits (200 megahertz and above), the effective resistance will be reduced as a result of shunt capacity between resistance elements and connecting circuits. The high frequency characteristics of these networks are not controlled.

2.7 Mounting. Under severe shock or vibration conditions (or a combination of both), resistors shall be mounted so that the body of the resistor network is restrained from movement with respect to the mounting base. If clamps are used, certain electrical characteristics may be altered. The heat-dissipating qualities will be enhanced or retarded depending on whether the clamping material is a good or poor heat conductor.

2.8 Screening. All resistor networks furninshed under MIL-R-83401 are subject to 100 percent screening through a 100-hour overload test plus a thermal shock test. These tests are followed by a total resistance check and a visual examination for evidence of arcing, burning, or charring.

3. ITEM IDENTIFICATION (see figures 501-2 and 501-3).

3.1 Part number designation. The part number designation is used for identifying and describing the resistor as shown on figure 501-2.

3.2 Performance characteristics. Performance characteristics are shown in table 501-I.

3.3 Resistance values. Resistance values shall follow the decade of values as shown in the following tabulation:

Standard resistance values for the 10 to 100 decade for 0.5%, 1.0%, 2.0%, and 5.0% resistance tolerances

Resistance tolerance

D (0.5)	F (1.0)	G (2.0) J (5.0)	D (0.5)	F (1.0)	G (2.0) J (5.0)	D (0.5)	F (1.0)	G (2.0) J (5.0)	D (0.5)	F (1.0)	G (2.0) J (5.0)	D (0.5)	F (1.0)	G (2.0) J (5.0)	D (0.5)	F (1.0)	G (2.0) J (5.0)
10.00	10.00	10.00	15.00	15.00	15.00	22.30	---	---	32.80	---	---	47.00	---	47.00	---	---	68.00
10.10	---	---	15.20	---	---	22.60	22.60	---	---	---	33.00	47.50	47.50	---	68.10	68.10	---
10.20	10.20	---	15.40	15.40	---	22.90	---	---	33.20	33.20	---	48.10	---	---	69.00	---	---
10.40	---	---	15.60	---	---	23.20	23.20	---	33.60	---	---	48.70	48.70	---	69.80	69.80	---
10.50	10.50	---	15.80	15.80	---	23.40	---	---	34.00	34.00	---	49.30	---	---	70.60	---	---
10.60	---	---	16.00	16.00	16.00	23.70	23.70	---	34.40	---	---	49.90	49.90	---	71.50	71.50	---
10.70	10.70	---	16.20	16.20	---	24.00	---	24.00	34.80	34.80	---	50.50	---	---	72.30	---	---
10.90	---	---	16.40	---	---	24.30	24.30	---	35.20	---	---	---	---	51.00	73.20	73.20	---
11.00	11.00	11.00	16.50	16.50	---	24.60	---	---	35.70	35.70	---	51.10	51.10	---	74.10	---	---
11.10	---	---	16.70	---	---	24.90	24.90	---	---	---	36.00	51.70	---	---	75.00	75.00	75.00
11.30	11.30	---	16.90	16.90	---	25.20	---	---	36.10	---	---	52.30	52.30	---	75.90	---	---
11.40	---	---	17.20	---	---	25.50	25.50	---	36.50	36.50	---	53.00	---	---	76.80	76.80	---
11.50	11.50	---	17.40	17.40	---	25.80	---	---	37.00	---	---	53.60	53.60	---	77.70	---	---
11.70	---	---	17.60	---	---	26.10	26.10	---	37.40	37.40	---	54.20	---	---	78.70	78.70	---
11.80	11.80	---	17.80	17.80	---	26.40	---	---	37.90	---	---	54.90	54.90	---	79.60	---	---
12.00	12.00	12.00	18.00	---	18.00	26.70	26.70	---	38.30	38.30	---	55.60	---	---	80.60	80.60	---
12.10	12.10	---	18.20	18.20	---	---	---	27.00	38.80	---	---	---	---	56.00	81.60	---	---
12.30	---	---	18.40	---	---	27.10	---	---	---	---	39.00	56.20	56.20	---	---	---	82.00
12.40	12.40	---	18.70	18.70	---	27.40	27.40	---	39.20	39.20	---	56.90	---	---	82.50	82.50	---
12.60	---	---	18.90	---	---	27.70	---	---	39.70	---	---	57.60	57.60	---	83.50	---	---
12.70	12.70	---	19.10	19.10	---	28.00	28.00	---	40.20	40.20	---	58.30	---	---	84.50	84.50	---
12.90	---	---	19.30	---	---	28.40	---	---	40.70	---	---	59.00	59.00	---	85.60	---	---
13.00	13.00	13.00	19.60	19.60	---	28.70	28.70	---	41.20	41.20	---	59.70	---	---	86.60	86.60	---
13.20	---	---	19.80	---	---	29.10	---	---	41.70	---	---	60.40	60.40	---	87.60	---	---
13.30	13.30	---	20.00	20.00	20.00	29.40	29.40	---	42.20	42.20	---	61.20	---	---	88.70	88.70	---
13.50	---	---	20.30	---	---	29.80	---	---	42.70	---	---	61.90	61.90	---	89.80	---	---
13.70	13.70	---	20.50	20.50	---	---	---	30.00	---	---	43.00	---	---	62.00	90.90	90.90	---
13.80	---	---	20.80	---	---	30.10	30.10	---	43.20	43.20	---	62.60	---	---	---	---	91.00
14.00	14.00	---	21.00	21.00	---	30.50	---	---	43.70	---	---	63.40	63.40	---	92.00	---	---
14.20	---	---	21.30	---	---	30.90	30.90	---	44.20	44.20	---	64.20	---	---	93.10	93.10	---
14.30	14.30	---	21.50	21.50	---	31.20	---	---	44.80	---	---	64.90	64.90	---	94.20	---	---
14.50	---	---	21.80	---	---	31.60	31.60	---	45.30	45.30	---	65.70	---	---	95.30	95.30	---
14.70	14.70	---	---	---	22.00	32.00	---	---	45.90	---	---	66.50	66.50	---	96.50	---	---
14.90	---	---	22.10	22.10	---	32.40	32.40	---	46.40	46.40	---	67.30	---	---	97.60	97.60	---
															98.80	---	---

M8340101 K 1002 J A

SPECIFICATION NUMBER: The number identifies the detail specification number (indicating MIL-R-83401/1).

CHARACTERISTIC: The single-letter symbol identifies the characteristic (at 70°C maximum ambient temperature at rated wattage) as follows:

V - - - - ±50 ppm/°C
H - - - - ±50 ppm/°C
K - - - - ±100 ppm/°C
M - - - - ±300 ppm/°C

RESISTANCE: The four-digit number identifies the nominal resistance value, expressed in ohms; the first three digits represent significant
* figures and the last digit specifies the number of zeros to follow. For values less than 100 ohms, all digits are significant with the letter "R" representing the decimal point. (See 3.3 and the following example.)

EXAMPLE:
10R0 - - - - - 10 ohms
1000 - - - - - 100 ohms
1001 - - - - - 1,000 ohms
1002 - - - - - 10,000 ohms
1003 - - - - - 100,000 ohms
1004 - - - - - 1,000,000 ohms

Standard resistance values. The standard resistance values and the resistance designators for the "J" schematic are as specified.

Resistance designator	R_1 (ohms)	R_2 (ohms)	Resistance designator	R_1 (ohms)	R_2 (ohms)
A001	82	130	A008	220	330
A002	120	200	A009	330	390
A003	130	210	A010	330	470
A004	160	260	A011	330	680
A005	180	240	A012	1.5 kΩ	3.3 kΩ
A006	180	390	A013	3 kΩ	6.2 kΩ
A007	220	270			

Standard resistance values. The standard resistance values and the resistance designators for the "H" schematic are as specified.

Resistance designator	R_1 (ohms)	R_2 (ohms)	Resistance designator	R_1 (ohms)	R_2 (ohms)
A001	82	130	A008	220	330
A002	120	200	A009	330	390
A003	130	210	A010	330	470
A004	160	260	A011	330	680
A005	180	240	A012	1.5 kΩ	3.3 kΩ
A006	180	390	A013	3 kΩ	6.2 kΩ
A007	220	270			

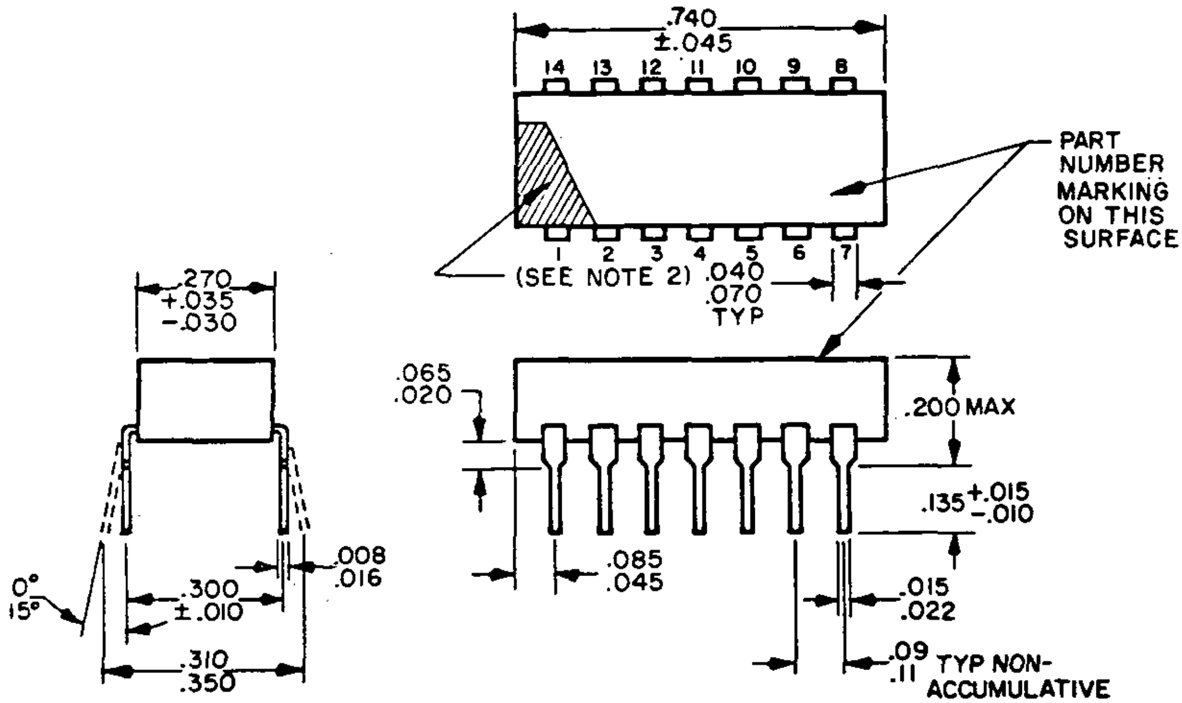
RESISTANCE TOLERANCE: The single-letter symbol identifies the resistance tolerance as follows:

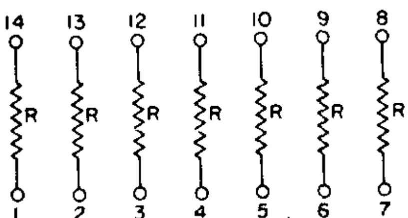
B - - - - - ±.1 percent
D - - - - - ±.5 percent
F - - - - - ±1 percent
G - - - - - ±2 percent
J - - - - - ±5 percent

SCHEMATIC: The single-letter symbol identifies the resistor network schematic in accordance with the drawings below. (Dotted lines in the schematic refer to configurations that might have additional resistors.)

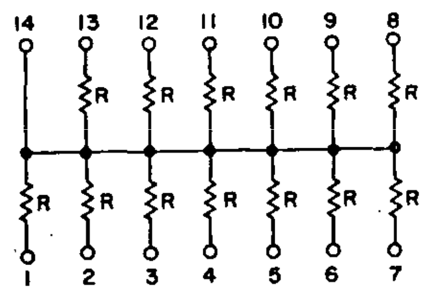
FIGURE 501-2. Part number example.

STYLE RZ010

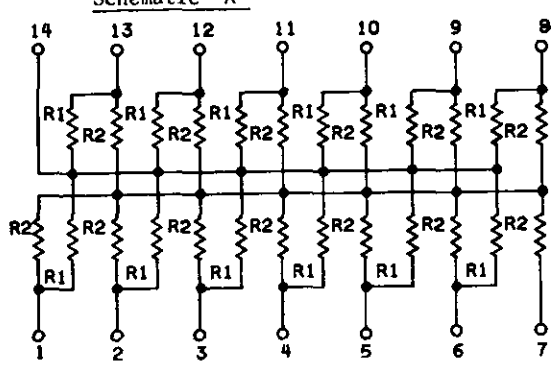




Schematic "A" 1/



Schematic "B" 1/



SCHEMATIC "J"

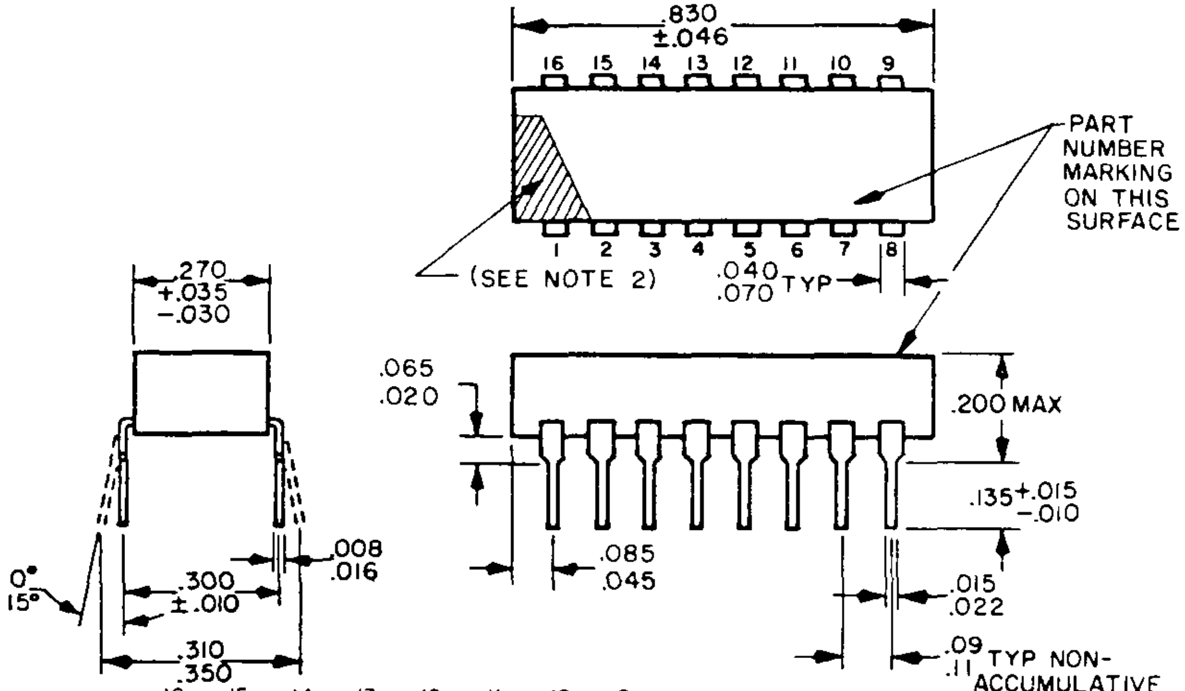
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
.008	.20	.022	.56	.065	1.65	.135	3.43	.350	8.89
.010	.25	.030	.76	.070	1.78	.200	5.08	.740	18.80
.015	.38	.035	.89	.085	2.16	.270	6.86		
.016	.41	.040	1.02	.090	2.29	.300	7.62		
.020	.51	.045	1.14	.110	2.79	.310	7.87		

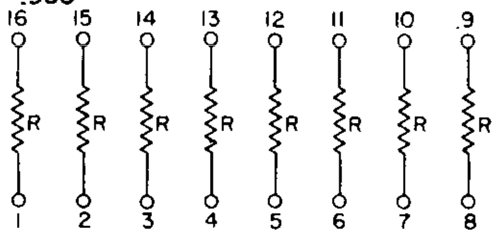
1/ All resistors are equal in value.

NOTES:
1. The picturization of this style is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.
2. Pin 1 locator is a dot, notch, or numeral 1 adjacent to pin No. 1 in the shaded area.

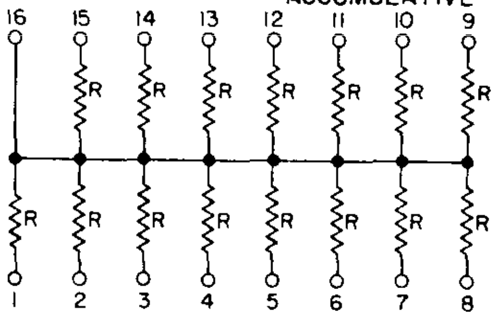
FIGURE 501-3. Fixed film resistor networks.

STYLE RZ020

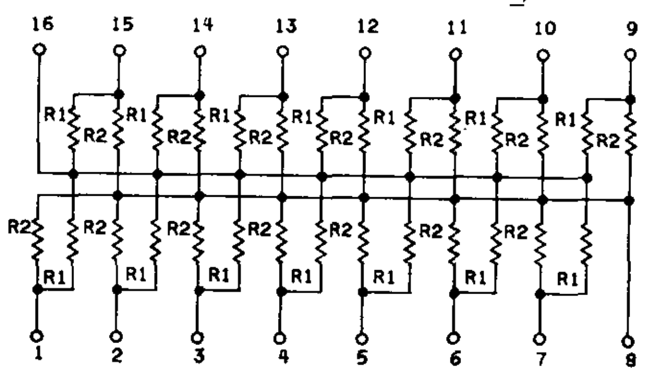




Schematic "A" 1/



Schematic "B" 1/



Schematic "J"

1/ All resistors are equal in value.

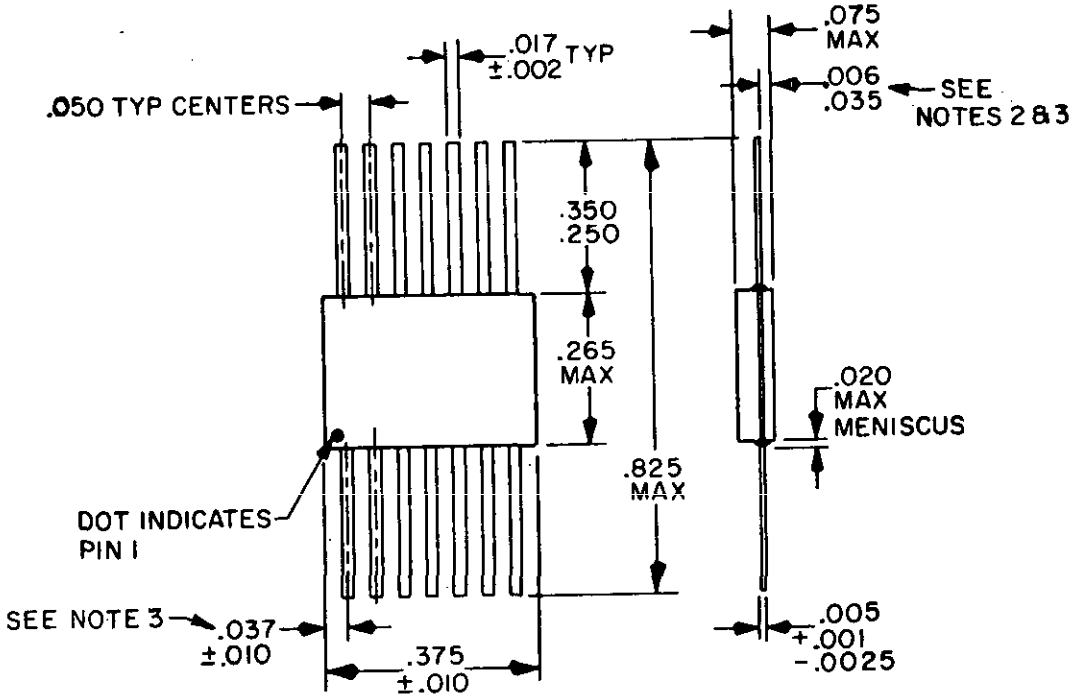
Inches	mm	Inches	mm
.008	.20	.070	1.78
.010	.25	.085	2.16
.015	.38	.090	2.29
.016	.41	.110	2.79
.020	.51	.135	3.43
.022	.56	.200	5.08
.030	.76	.270	6.86
.035	.89	.300	7.62
.040	1.02	.310	7.87
.045	1.14	.350	8.89
.046	1.17	.830	21.08
.065	1.65		

NOTES:

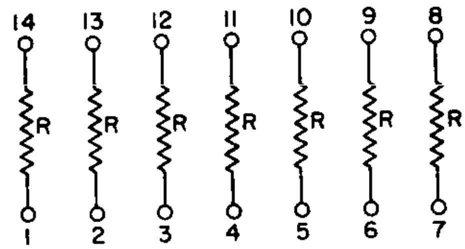
1. The picturization of this style is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.
2. Pin 1 locator is a dot, notch, or numeral 1 adjacent to pin No. 1 in the shaded area.

FIGURE 501-3. Fixed film resistor networks - Continued.

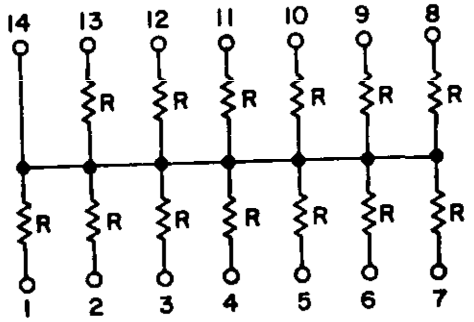
STYLE RZ030



Schematic "A"1/



Schematic "B"1/



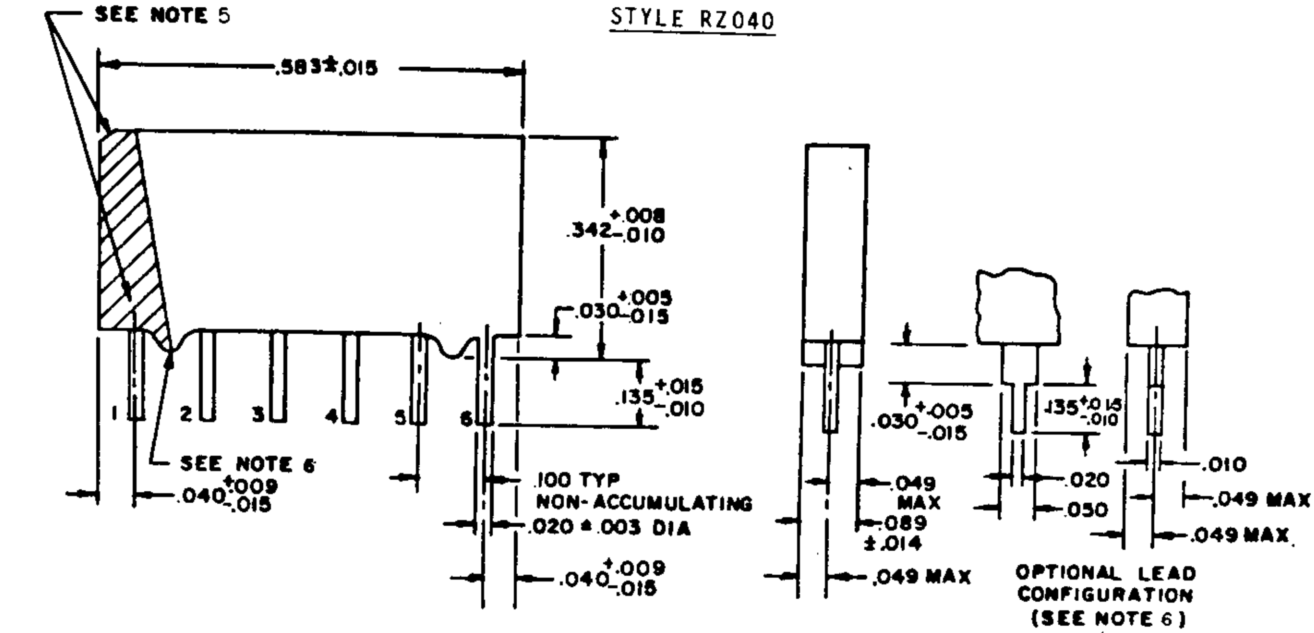
Inches	mm	Inches	mm
.0003	.01	.035	.89
.001	.03	.037	.94
.002	.05	.050	1.27
.0025	.06	.065	1.65
.003	.08	.075	1.91
.005	.13	.25	6.35
.006	.15	.265	6.73
.010	.25	.35	8.89
.017	.43	.375	9.53
.020	.51	.825	20.96

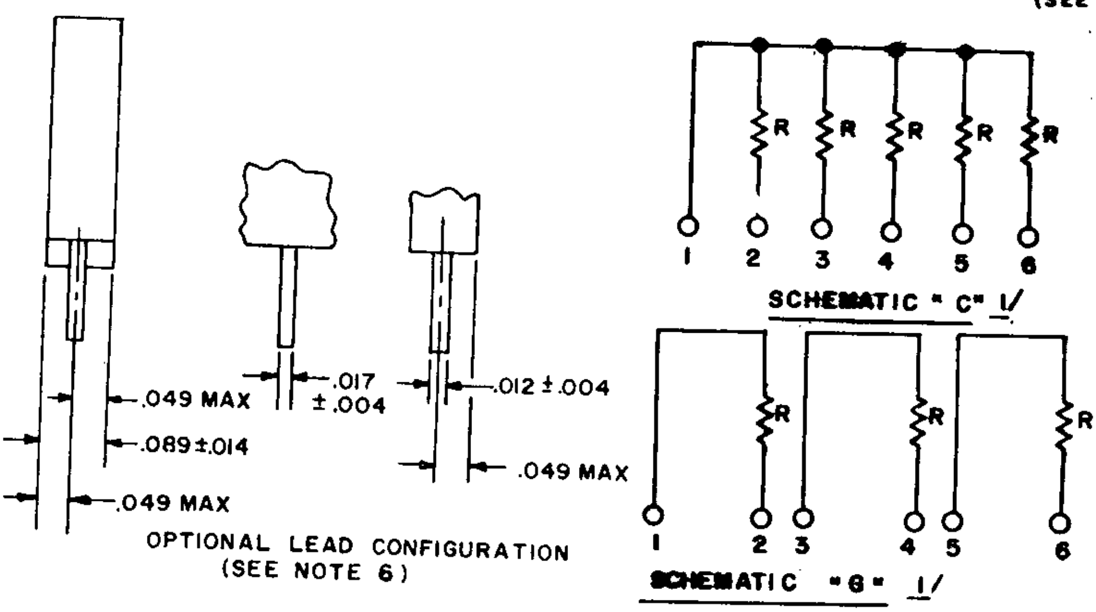
1/ All resistors are equal in value.

NOTES:
1. The picturization of this style is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.
2. Measurement made to edge of terminal.
3. Measurement made at point of emergence of the lead from the body.

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ040





Inches	mm
.003	.08
.005	.13
.008	.20
.009	.23
.010	.25
.012	.30
.013	.33
.014	.36
.015	.38
.017	.43
.020	.51
.030	.76
.040	1.02
.041	1.04
.049	1.24
.050	1.27
.082	2.08
.089	2.26
.100	2.54
.135	3.43
.342	8.69
.583	14.81

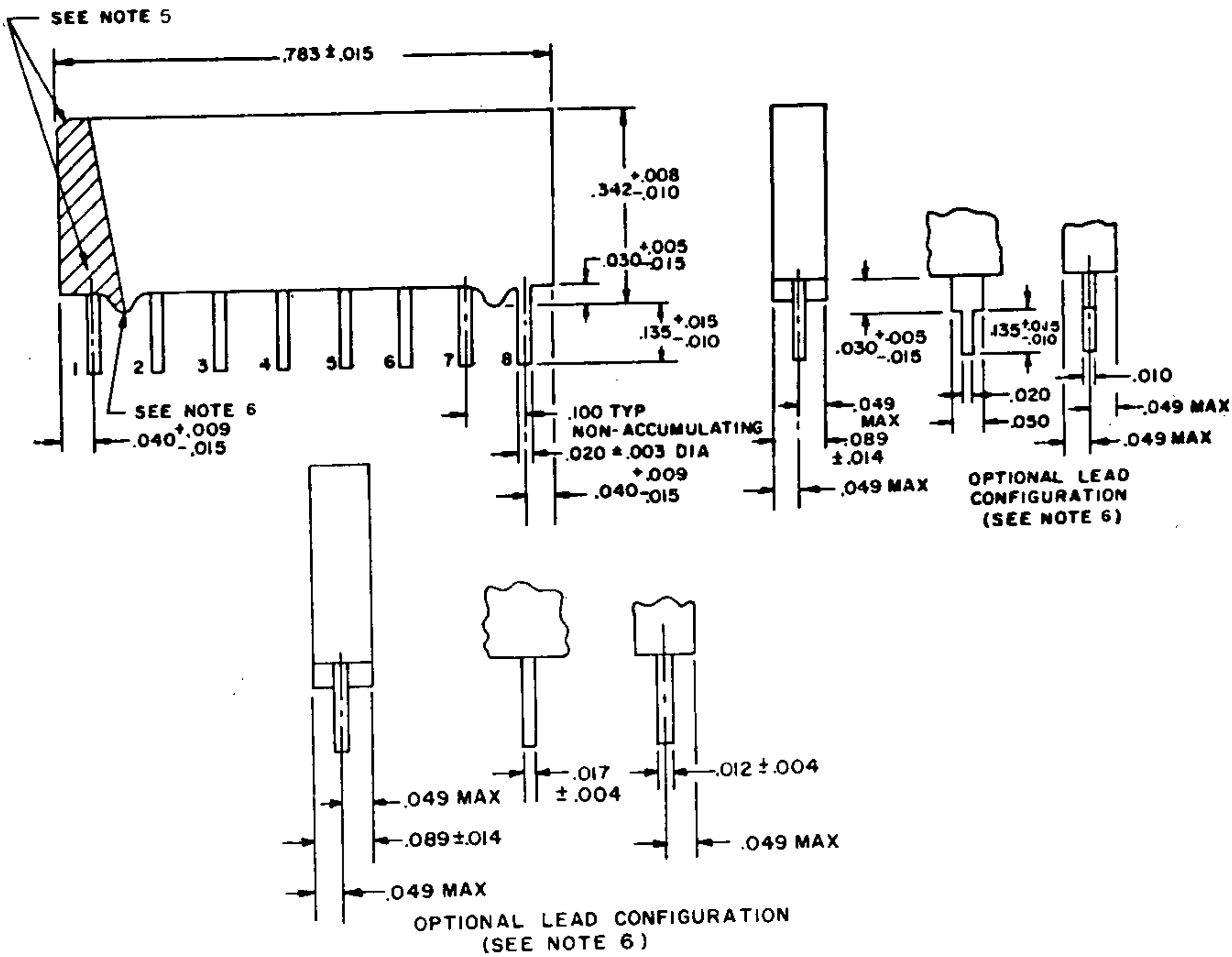
1/ALL RESISTORS ARE EQUAL IN VALUE

NOTES:

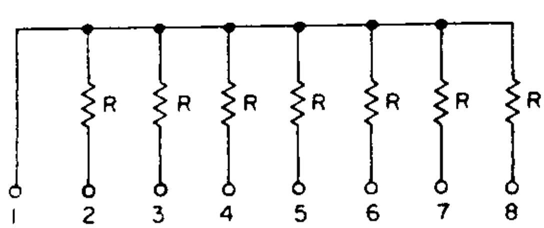
1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The picturization of this style is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.
3. Measurement made to edge of terminal.
4. Measurement made at point of emergence of the lead from the body.
5. Pin 1 locator is a bevel or numeral 1 or a dot adjacent to pin No. 1 in the shaded area.
6. If standoffs are located on the body, a minimum of two standoffs are required as illustrated. As an option, additional standoffs may be located on the body of the resistor network. If the optional lead configuration is used, standoffs on the body are not required.

FIGURE 501-3. Fixed film resistor networks - Continued.

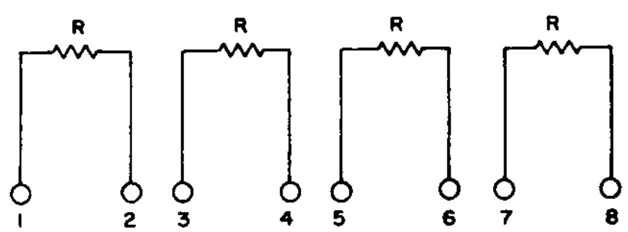
STYLE RZ050



SCHEMATIC "C" 1/



SCHEMATIC "G" 1/



1/ALL RESISTORS ARE EQUAL IN VALUE

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ050 - Continued

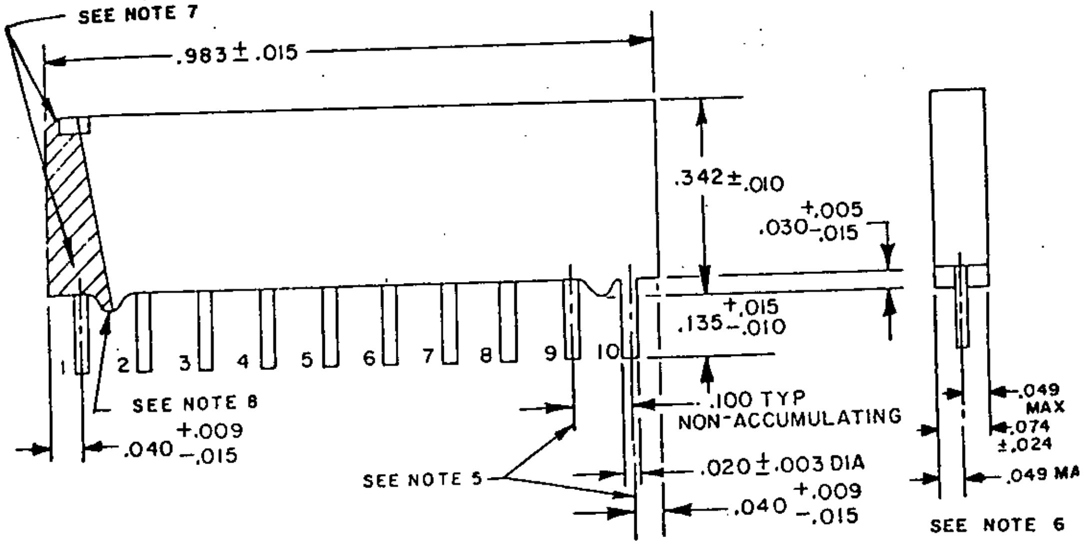
Inches	mm	Inches	mm
.003	.08	.030	.76
.004	.10	.040	1.02
.005	.13	.041	1.04
.008	.20	.049	1.24
.009	.23	.050	1.27
.010	.25	.082	2.08
.012	.30	.089	2.26
.013	.33	.100	2.54
.015	.38	.135	3.43
.017	.43	.342	8.69
.020	.51	.783	19.89

NOTES:

1. Unless otherwise specified, tolerance is ±.005 (.13 mm).
2. The picturization of this style is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.
3. Measurement made to edge of terminal.
4. Measurement made at point of emergence of the lead from the body.
5. Pin 1 locator is a bevel or numeral 1 or a dot adjacent to pin No. 1 in the shaded area.
6. If standoffs are located on the body, a minimum of two standoffs are required as illustrated. As an option, additional standoffs may be located on the body of the resistor network. If the optional lead configuration is used, standoffs on the body are not required.

FIGURE 501-3. Fixed film resistor networks - Continued.

Style RZ060



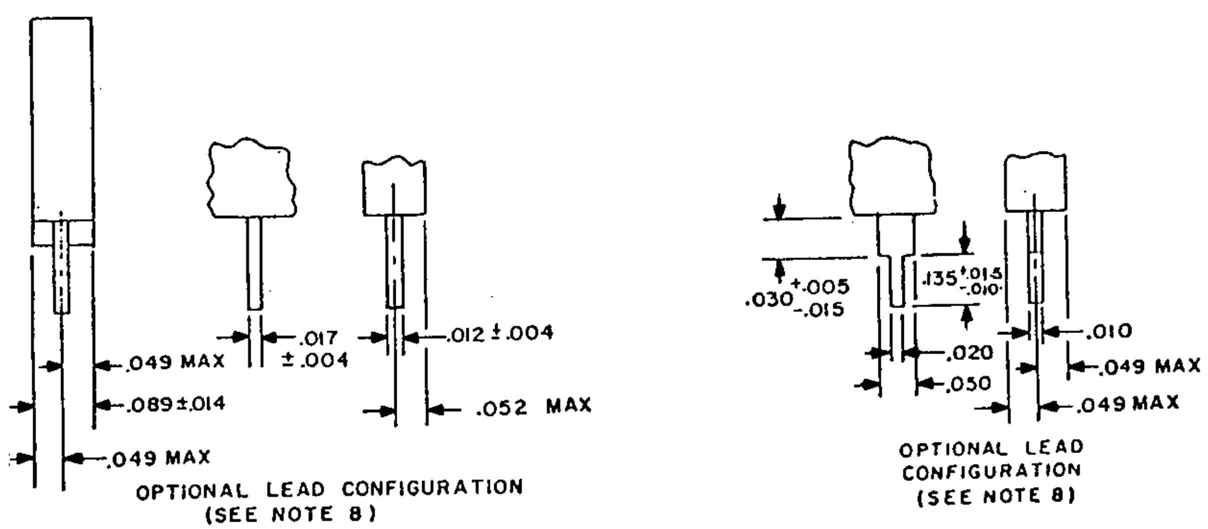
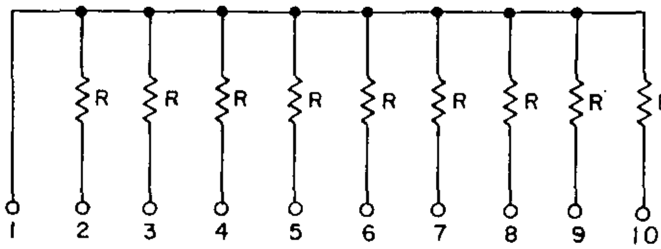
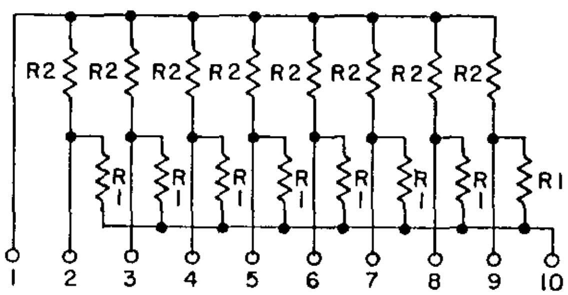


FIGURE 501-3. Fixed film resistor networks - Continued.

Style RZ060--Continued

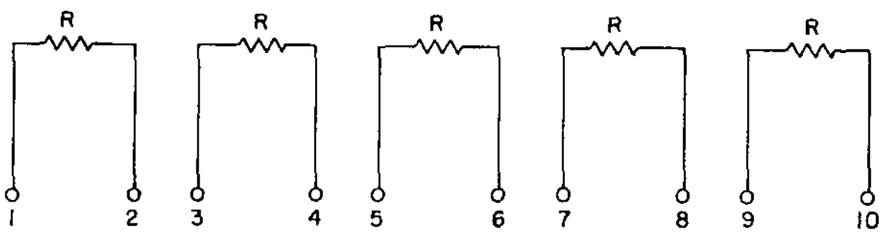


SCHEMATIC C



SCHEMATIC H

Inches	mm	Inches	mm
.003	0.08	.030	0.76
.004	0.10	.40	1.02
.005	0.13	.049	1.24
.009	0.23	.050	1.27
.010	0.25	.052	1.32
.012	0.30	.074	1.88
.014	0.36	.089	2.26
.015	0.38	.100	2.54
.017	0.43	.135	3.43
.020	0.51	.342	8.69
.024	0.61	.983	24.97

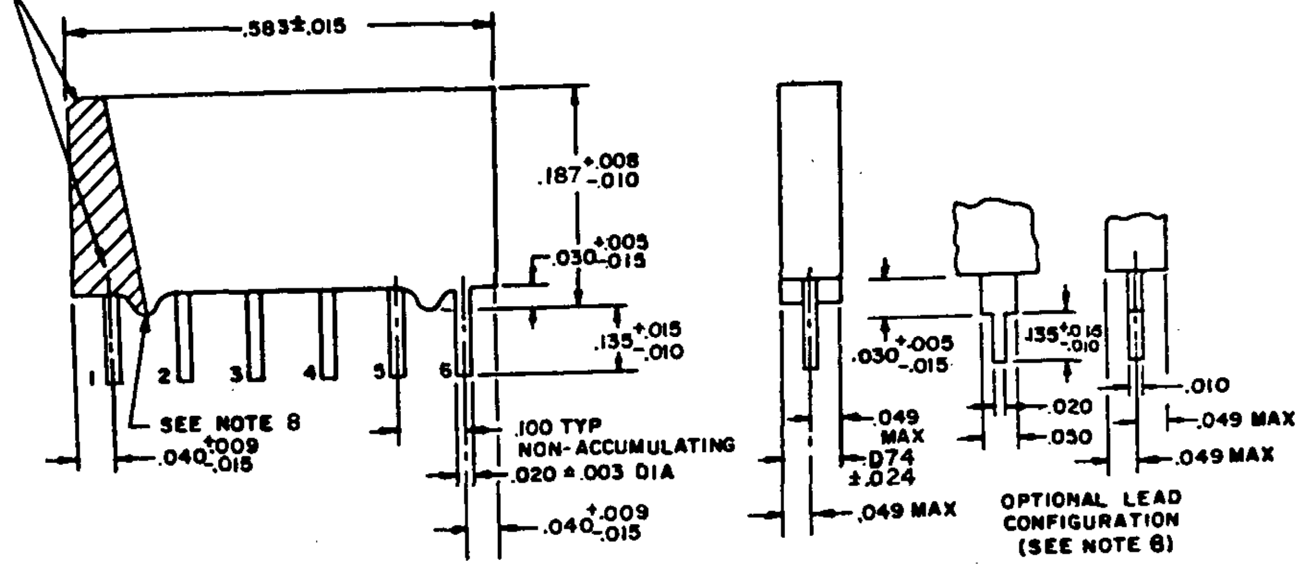


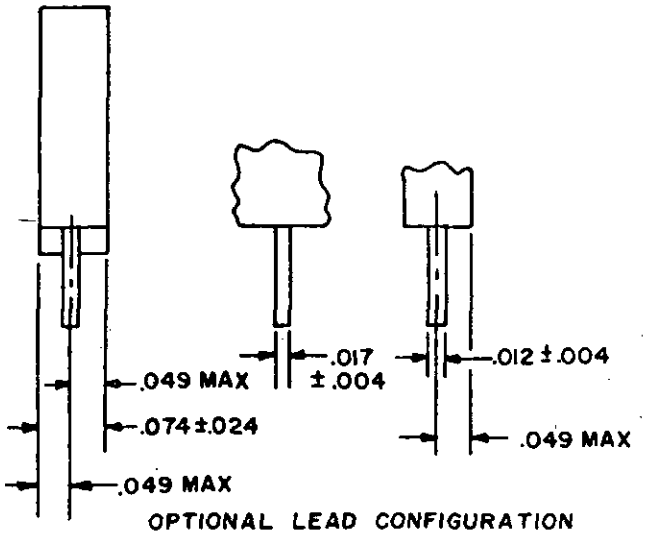
SCHEMATIC G

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerances are ±.005 (0.13 mm).
4. The picturization of the styles above is given as representative of the envelope of the item. Slight deviations from the outline shown, which are contained within the envelope and do not alter the functional aspects of the device, are acceptable.
5. Terminal centerline to centerline measurements made at point of emergence of the lead from the body.
6. Measurement made at point of emergence of the lead from the body.
7. Pin 1 locator shall be a bevel, numeral 1, or a dot adjacent to pin No. 1 in the shaded area.
8. If the standoffs are located on the body, a minimum of two standoffs are required as illustrated. As an option, additional standoffs may be located on the body of the resistor network. If leads with standoffs are used, standoffs on the body are not required.

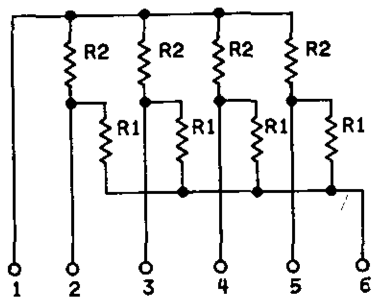
FIGURE 501-3. Fixed film resistor networks - Continued.

Style RZ070

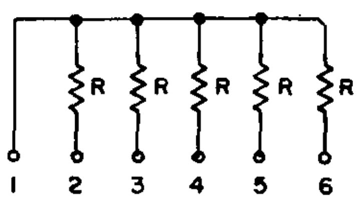




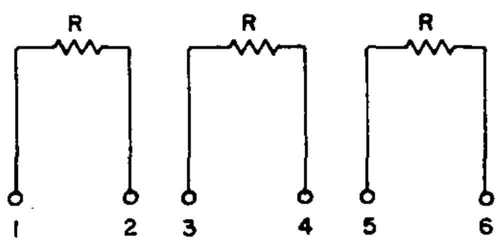
OPTIONAL LEAD CONFIGURATION
(SEE NOTE 8)



SCHEMATIC "H"



SCHEMATIC C 1/



SCHEMATIC G 1/

1/ All resistors are equal in value.

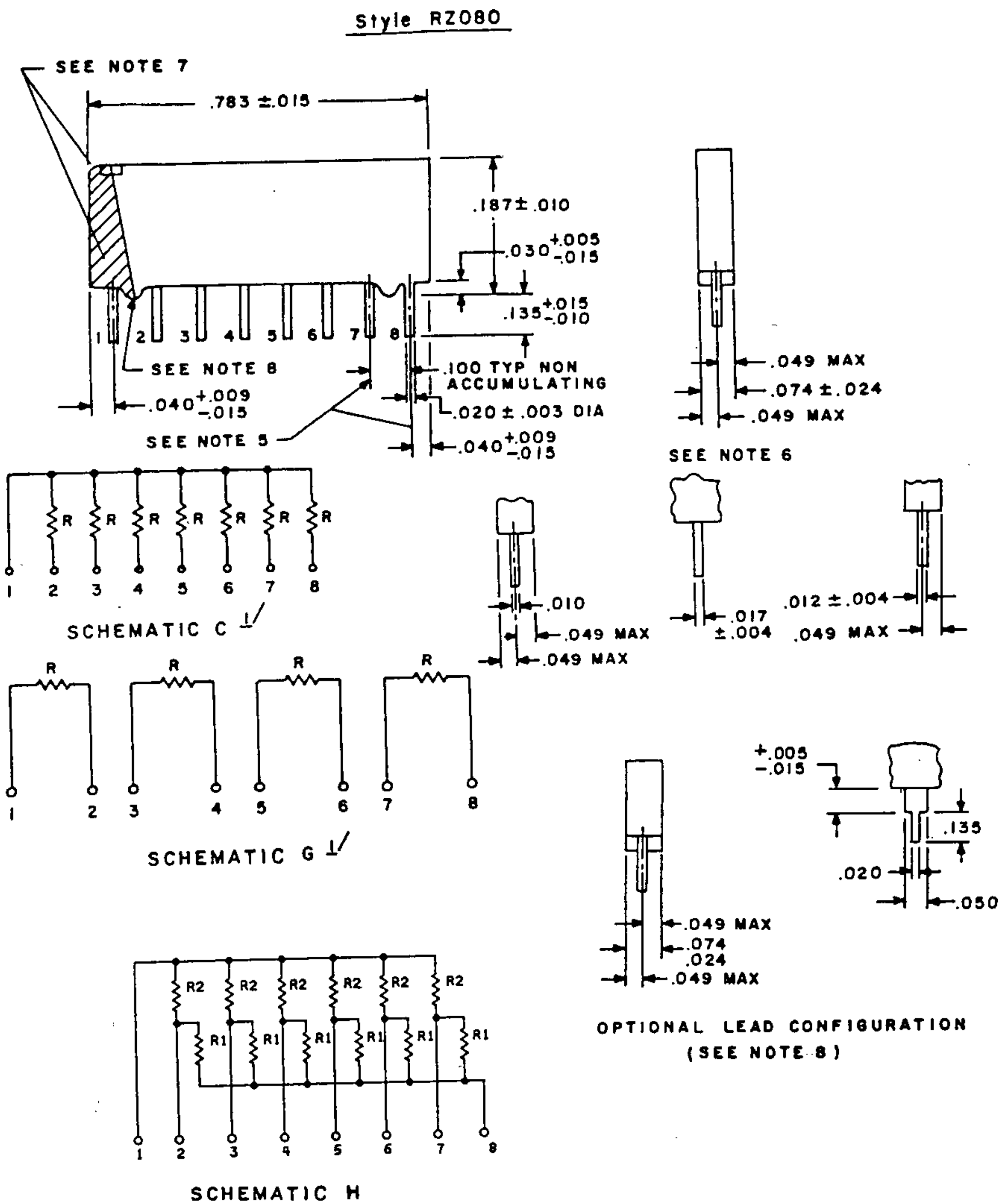
FIGURE 501-3. Fixed film resistor networks - Continued.

Style RZ070 - continued

Inches	mm	Inches	mm
.003	.08	.024	.61
.004	.10	.030	.76
.005	.13	.040	1.02
.008	.20	.049	1.24
.009	.23	.050	1.27
.010	.25	.074	1.88
.012	.30	.089	2.26
.014	.36	.100	2.54
.015	.38	.135	3.43
.017	.43	.187	4.75
.020	.51	.583	14.81

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerances are ±.005 (.13 mm).
4. The picturization of the styles above is given as representative of the envelope of the item. Slight deviations from the outline shown, which are contained within the envelope and do not alter the functional aspects of the device, are acceptable.
5. Terminal centerline to centerline measurements made at point of emergence of the lead from the body.
6. Measurement made at point of emergence of the lead from the body.
7. Pin 1 locator shall be a bevel, numeral 1, or a dot adjacent to pin No. 1 in the shaded area.
8. If the standoffs are located on the body, a minimum of two standoffs are required as illustrated. As an option, additional standoffs may be located on the body of the resistor network. If leads with standoffs are used, standoffs on the body are not required.

FIGURE 501-3. Fixed film resistor networks - Continued.



1/ All resistors are equal in value.

FIGURE 501-3. Fixed film resistor networks - Continued.

Style RZ080 - continued

Inches	mm	Inches	mm
.003	.08	.024	.61
.004	.10	.030	.76
.005	.13	.040	1.02
.009	.23	.049	1.24
.010	.25	.050	1.27
.012	.30	.074	1.88
.014	.36	.089	2.26
.015	.38	.100	2.54
.017	.43	.135	3.43
.020	.51	.187	4.75
		.783	19.89

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerances are ±.005 (.13 mm).
4. The picturization of the styles above is given as representative of the envelope of the item. Slight deviations from the outline shown, which are contained within the envelope and do not alter the functional aspects of the device, are acceptable.
5. Terminal centerline to centerline measurements made at point of emergence of the lead from the body.
6. Measurement made at point of emergence of the lead from the body.
7. Pin 1 locator shall be a bevel, numeral 1, or a dot adjacent to pin No. 1 in the shaded area.
8. If the standoffs are located on the body, a minimum of two standoffs are required as illustrated. As an option, additional standoffs may be located on the body of the resistor network. If leads with standoffs are used, standoffs on the body are not required.

FIGURE 501-3. Fixed film resistor networks - Continued.

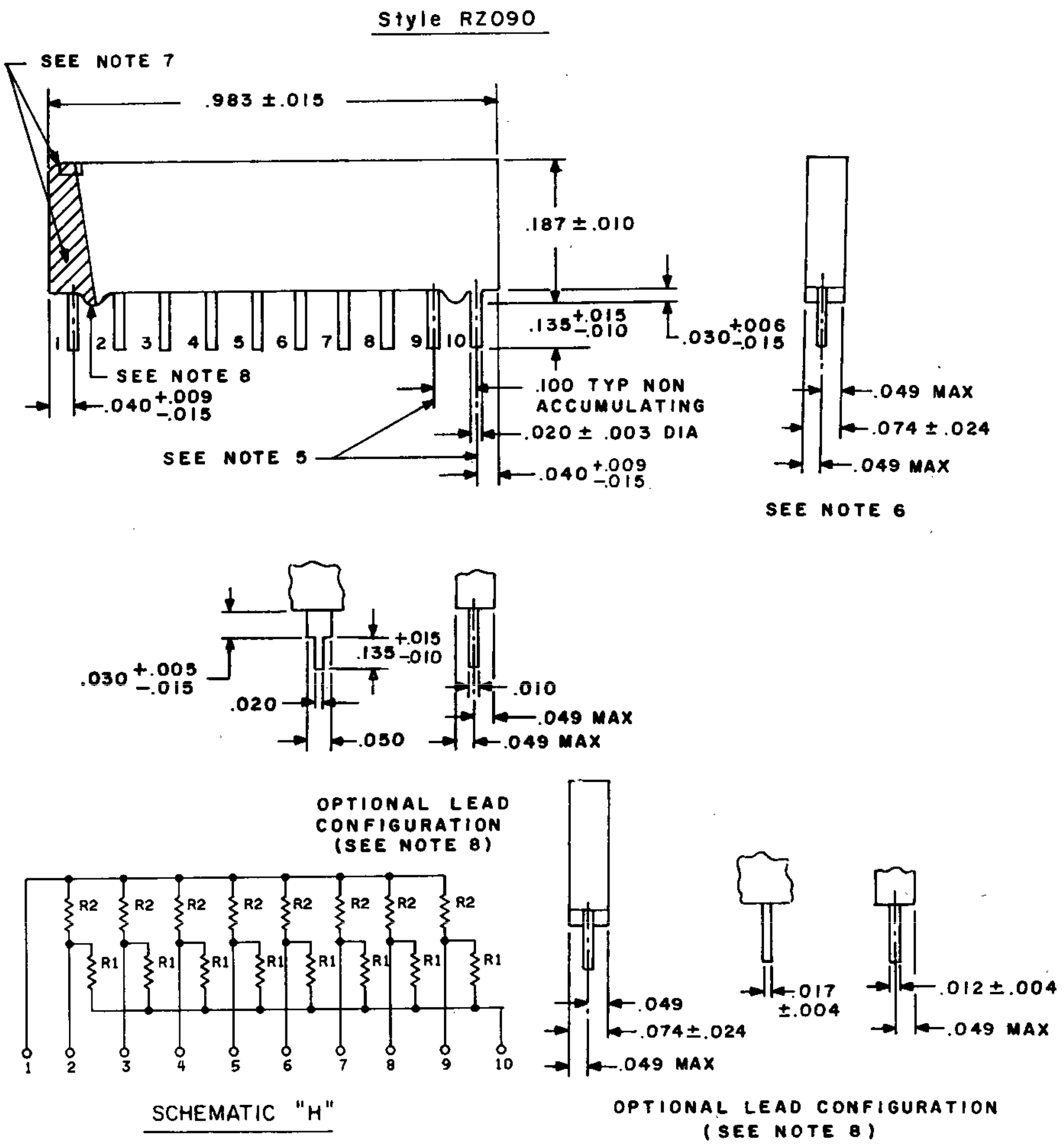
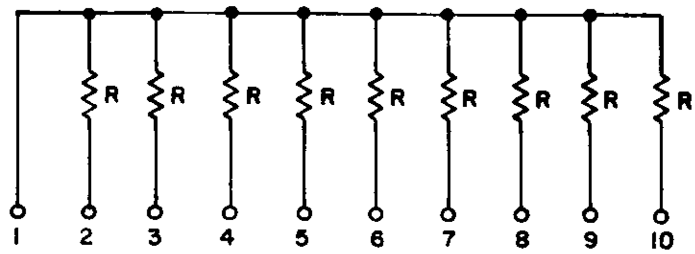
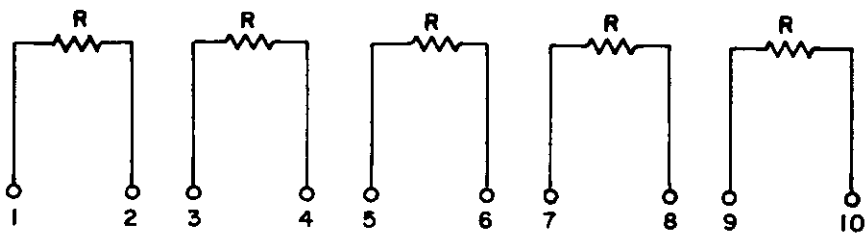


FIGURE 501-3. Fixed film resistor networks - Continued.

Styel RZ090 - Continued



SCHEMATIC C 1/



SCHEMATIC G 1/

1/ All resistors are equal in value.

Inches	mm	Inches	mm
.003	.08	.024	.61
.004	.10	.030	.76
.005	.13	.040	1.02
.009	.23	.049	1.24
.010	.25	.050	1.27
.012	.30	.074	1.88
.014	.36	.089	2.26
.015	.38	.100	2.54
.017	.43	.135	3.43
.020	.51	.187	4.75
		.983	24.97

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerances are ±.005 (.13 mm).
4. The picturization of the styles above is given as representative of of the envelope of the item. Slight deviations from the outline shown, which are contained within the envelope and do not alter the functional aspects of the device, are acceptable.
5. Terminal centerline to centerline measurements made at point of emergence of the lead from the body.
6. Measurement made at point of emergence of the lead from the body.
7. Pin 1 locator shall be a bevel, numeral 1, or a dot adjacent to pin No. 1 in the shaded area.
8. If the standoffs are located on the body, a minimum of two standoffs are required as illustrated. As an option, additional standoffs may be located on the body of the resistor network. If leads with standoffs are used, standoffs on the body are not required.

FIGURE 501-3. Fixed film resistor networks - Continued.

TABLE 501-1. Performance characteristics.

Features	H		K		M		V		C	
Resistance temperature characteristic, ppm/°C	±50		±100		±300		±50		±50	
Maximum ambient temperature at rated wattage	70°C		70°C		70°C		70°C		70°C	
Maximum ambient temperature at zero power derating	125°C		125°C		125°C		125°C		125°C	
Maximum operating voltage for each resistor (volts):										
Style RZ010	100 V		100 V		100 V		100 V		100 V	
Style RZ020	100 V		100 V		100 V		100 V		100 V	
Style RZ030	50 V		50 V		50 V		N/A		N/A	
Style RZ040	N/A 1/		50 V		50 V		"		"	
* Style RZ050	"		50 V		50 V		"		"	
Style RZ070	"		50 V		50 V		"		"	
Style RZ080	"		50 V		50 V		"		"	
Style RZ080	"		50 V		50 V		"		"	
Power rating (watts) at 70°C:	Element	Network	Element	Network	Element	Network	Element	Network	Element	Network
Style RZ010 Schematic A	.2	1.4	.2	1.4	.2	1.4	.1	.7	.1	.7
Schematic B	.1	1.3	.1	1.3	.1	1.3	N/A	N/A	N/A	N/A
Schematic J	N/A	N/A	.05	1.2	.05	1.2	N/A	N/A	N/A	N/A
Style RZ020 Schematic A	.2	1.6	.2	1.6	.2	1.6	.1	.8	.1	.8
Schematic B	.10	1.5	.10	1.5	.10	1.5	N/A	N/A	N/A	N/A
Schematic J	N/A	N/A	.05	1.4	.05	1.4	"	"	"	"
Style RZ030 Schematic A	.05	.35	.05	.35	.05	.35	"	"	"	"
Schematic B	.025	.325	.025	.325	.025	.325	"	"	"	"
Schematic J	.015	.35	.015	.35	.015	.35	"	"	"	"
Style RZ040 Schematic C	N/A	N/A	.2	1.8	.2	1.8	"	"	"	"
Schematic H	"	"	.11	1.8	.11	1.8	"	"	"	"
Schematic G	"	"	.2	1.0	.2	1.0	"	"	"	"
Style RZ050 Schematic C	"	"	.2	1.8	.2	1.8	"	"	"	"
Schematic H	"	"	.11	1.8	.11	1.8	"	"	"	"
Schematic G	"	"	.2	1.0	.2	1.0	"	"	"	"
* Style RZ060 Schematic C	"	"	.2	1.8	.2	1.8	"	"	"	"
Schematic H	"	"	N/A	N/A	N/A	N/A	"	"	"	"
Schematic G	"	"	.2	1.0	.2	1.0	"	"	"	"
Style RZ070 Schematic C	.12	.60	.12	.60	.12	.60	"	"	"	"
Schematic H	N/A	N/A	.07	.60	.07	.60	"	"	"	"
Schematic G	.12	.36	.12	.36	.12	.36	"	"	"	"
* Style RZ080 Schematic C	.12	.84	.12	.84	.12	.84	"	"	"	"
Schematic H	N/A	N/A	.07	.84	.07	.84	"	"	"	"
Schematic G	.12	.48	.12	.48	.12	.48	"	"	"	"
Style RZ090 Schematic C	.12	1.08	.12	1.08	.12	1.08	"	"	"	"
Schematic H	N/A	N/A	.12	.60	.12	.60	"	"	"	"
Schematic G	.12	.60	.07	1.08	.07	1.08	"	"	"	"
Power rating (watts) at 25°C:	Element	Network	Element	Network	Element	Network	Element	Network	Element	Network
Style RZ010 Schematic A	.25	1.75	.25	1.75	.25	1.75	.125	.875	.825	.875
Schematic B	.125	1.625	.125	1.625	.125	1.625	N/A	N/A	N/A	N/A
Schematic J	N/A	N/A	.06	1.44	.06	1.44	N/A	N/A	N/A	N/A
Style RZ020 Schematic A	.25	2.0	.25	.20	.25	2.0	.125	1.00	.125	1.00
Schematic B	.125	1.875	.125	1.875	.125	1.875	N/A	N/A	N/A	N/A
Schematic J	N/A	N/A	.06	1.68	.06	1.68	"	"	"	"
Style RZ030 Schematic A	.063	.438	.063	.438	.063	.438	"	"	"	"
Schematic B	.031	.406	.031	.406	.031	.406	"	"	"	"
Schematic J	.019	.45	.019	.45	.019	.45	"	"	"	"
Style RZ040 Schematic C	N/A	N/A	.25	2.25	.25	2.25	"	"	"	"
Schematic H	"	"	.25	1.25	.25	1.25	"	"	"	"
Schematic G	"	"	.14	2.25	.14	2.25	"	"	"	"
Style RZ050 Schematic C	"	"	.25	2.25	.25	2.25	"	"	"	"
Schematic H	"	"	.14	2.25	.14	2.25	"	"	"	"
Schematic G	"	"	.25	1.25	.25	1.25	"	"	"	"
* Style RZ060 Schematic C	"	"	.25	2.25	.25	2.25	"	"	"	"
Schematic H	"	"	N/A	N/A	N/A	N/A	"	"	"	"
Schematic G	"	"	.25	1.25	.25	1.25	"	"	"	"
Style RZ070 Schematic C	.15	.75	.15	.75	.15	.75	"	"	"	"
Schematic H	N/A	N/A	.09	.75	.09	.75	"	"	"	"
Schematic G	.15	.45	.15	.45	.15	.45	"	"	"	"
* Style RZ080 Schematic C	.15	1.05	.15	1.05	.15	1.05	"	"	"	"
Schematic H	N/A	N/A	.09	1.05	.09	1.05	"	"	"	"
Schematic G	.15	.60	.15	.60	.15	.60	"	"	"	"
Style RZ090 Schematic C	.15	1.35	.15	1.35	.15	1.35	"	"	"	"
Schematic H	N/A	N/A	.09	1.35	.09	1.35	"	"	"	"
Schematic G	.15	.75	.15	.75	.15	.75	"	"	"	"

See footnotes at end of table.

TABLE 501-I. Performance characteristics - Continued.

Features	H		K		M		V		C	
Minimum and Maximum resistance values:	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Style RZ010	100	70 kΩ	10	1 MΩ	10	1 MΩ	1 kΩ	.2 MΩ	100	1 MΩ
Style RZ020	100	70 kΩ	10	1 MΩ	10	1 MΩ	1 kΩ	.2 MΩ	10	1 MΩ
Style RZ030	150	51.5 kΩ	10	1 MΩ	10	1 MΩ				
Style RZ040			10	1 MΩ	10	1 MΩ				
Style RZ050			10	1 MΩ	10	1 MΩ				
* Style RZ060			10	1 MΩ	10	1 MΩ				
Style RZ070	100	46.4 kΩ	27	1 MΩ	27	1 MΩ				
Style RZ080	100	46.4 kΩ	27	1 MΩ	27	1 MΩ				
Style RZ090	100	46.4 kΩ	27	1 MΩ	27	1 MΩ				
Maximum percent change in resistance: 2/										
Thermal shock	±.5 3/		±.7 3/		±.7 3/		±.25 3/		±.25	
Power conditioning	±.5 3/		±.7 3/		±.7 3/		±.25 3/		±.25	
Low temperature operation	±.10		±.25		±.50		±.10		±.10	
Short time overload	±.10		±.25		±.50		±.10		±.10	
Terminal strength	±.25		±.25		±.25		±.10		±.10	
Resistance to soldering heat	±.10		±.25		±.25		±.10		±.10	
Moisture resistance	±.40		±.50		±.50		±.20		±.20	
Shock (specified pulse)	±.25		±.25		±.25		±.25		±.25	
Vibration	±.25		±.25		±.25		±.25		±.25	
Life	±.50		±.50		±.20		±.10		±.10	
High temperature exposure	±.20		±.50		±1.0		±.10		±.10	
Low temperature storage	±.10		±.25		±.50		±.10		±.10	
Insulation resistance	10,000 megohms		10,000 megohms		10,000 megohms		10,000 megohms		10,000 megohms	
Resistance tolerance	±.10% (B) ±.50% (D) ±1.0% (F) ±2.0% (G) ±5.0% (J)		±.10% (B) ±.50% (D) ±1.0% (F) ±2.0% (G) ±5.0% (J)		±.10% (B) ±.50% (D) ±1.0% (F) ±2.0% (G) ±5.0% (J)		±.10% (B) ±.50% (D) ±1.0% (F) ±2.0% (G) ±5.0% (J)		±.10 (B) ±.50 (D) ±1.0% (F)	

1/ Not available (NA).
2/ Where total resistance change is 1 percent or less, it shall be considered as ± (percent ±0.01 ohm).
3/ Maximum percent change for combined thermal shock and power conditioning tests.

SECTION 502

THERMISTORS, (THERMALLY SENSITIVE RESISTOR) INSULATED

(APPLICABLE SPECIFICATION: MIL-T-23648)

1. SCOPE.

1.1 Scope. This section covers the (negative and positive temperature coefficient) insulated thermistor which are use in temperature compensation circuits and control and measuring circuits.

2. APPLICATION INFORMATION

2.1 Style selection.

2.1.1 Construction. Thermistors are manufactured from oxides of nickle, manganese, iron, colbolt, copper, magnesium, titanium and other metals. Conductance of each grade is characteristic of the chemical proportions of each element and temperature. Thermistors shall be constructed so as to provide protection against exposure to humidity and temperature conditions by means of an enclosure or a coating of moisture resistant insulating material.

2.1.2 Power rating. Thermistors have a power rating based on continuous, full-load operation at an ambient temperature of 25°C. If thermistors are to be operated at temperatures exceeding 25°C, the thermistors must be derated in accordance with figure 502-1.

Style	Watts at 25°C
RTH 06	.5 W
RTH 08	1 W
RTH 10	1.5 W
RTH 22	.5 W
RTH 42	.25 W

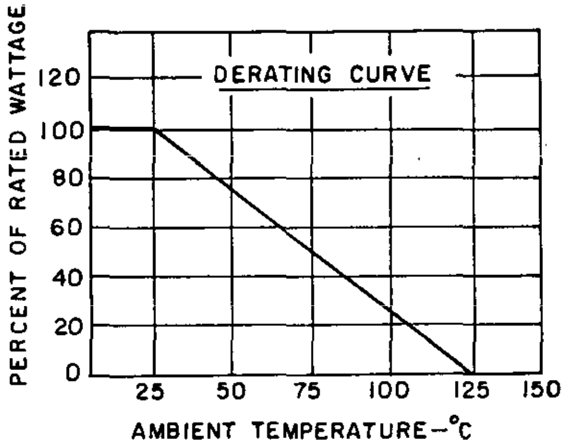


FIGURE 502-1. Power ratings and derating curve.

2.1.3 Zero-power resistive tolerance. The zero-power resistance tolerance varies according to variations in temperature and shall be in accordance with table 502-I.

TABLE 502-I. Resistance tolerance vs temperature for each resistance tolerance.

Sequence	Temperature (°C)	F ± Percent	G ± Percent	J ± Percent	K ± Percent
1	-55	10	12	15	20
2	-15	5	6	9	14
3	0	3	4	7	12
4	25	1	2	5	10
5	50	3	4	7	12
6	75	5	6	9	14
7	100	7	9	12	17
8	125	10	12	15	20

2.1.4 Resistance temperature characteristic. The resistance temperature characteristic of a thermistor shall fall within the requirements specified herein. For resistance temperature charactertistic ratio A, B, or C, use table 502-II. For ratio E, use table 502-III.

TABLE 502-II. Resistance temperature characteristic factors.

Temperature °C	Ratio 19.8 (A)	Ratio 29.4 (B)	Ratio 48.7 (C)
-55	54.9	100	---
-15	5.77	7.38	8.80
0	2.85	3.27	3.36
25	1.00	1.00	1.00
50	.405	.360	.320
75	.184	.148	.116
100	.0923	.0675	.047
125	.0503	.0340	.0205

TABLE 502-III. Factors for determining resistance at various temperatures.

Temperature °C	10-68	82-150	180-560	680-1.8 kΩ	1.8 K-12 kΩ	15 K- 39 kΩ
-55	.615	.582	.560	.550	.515	.481
-15	.790	.770	.755	.740	.730	.712
0	.863	.847	.838	.835	.825	.814
25	1.000	1.000	1.000	1.000	1.000	1.000
50	1.160	1.170	1.180	1.200	1.230	1.210
75	1.350	1.370	1.400	1.420	1.450	1.430
100	1.545	1.584	1.623	1.656	1.670	1.670
125	1.750	1.800	1.860	1.920	1.960	1.900

EXAMPLE: Given a thermistor with a 25°C resistance of 200 ohms, find the resistance at 75°C.

Select the factor opposite 75°C from the column headed by the resistance range containing 220 ohms. The factor 1.400 is thus selected from the column leaded 180-560. Multiply 220 ohms by the factor 1.400 to obtain the resistance at 75°C of 308 ohms.

2.3 Definitions

2.3.1 Thermistor. A device whose primary function is to exhibit a change in electrical resistance with a change in body temperature.

2.3.2 Standard reference temperature. The standard reference temperature is the thermistor body temperature at which nominal zero-power resistance is specified (25°C).

2.3.3 Zero-power resistance. The dc resistance value of a thermistor measured at a specified temperature with a power dissapation of the thermistor low enough that any further decrease in power will result in not more than 0.1 percent (or 1/10 of the specified measurement tolerance, whichever, is smaller) change in resistance.

2.3.4 Resistance ratio characteristic. The ratio of the zero-power resistance of a thermistor measured at 25°C to that resistance measured at 125°C.

2.3.5 Zero power temperature coefficent of resistance. The ratio at a specified temperature of the rate of change of zero power resistance with temperature to the zero power resistance of the thermistor.

2.3.6 Negative temperature coefficient (NTC). A NTC thermistor is one in which the zero power resistance decreases with an increase in temperature.

2.3.7 Positive temperature coefficient (PTC). PTC thermistor is one in which the zero power resistance increases with an increase in temperature.

2.3.8 Dissipation constant. The ratio, (in milliwatts per degree °C) at a specified ambient temperature, of a change in power dissipation in a thermistor to the resultant body temperature change.

2.3.9 Thermal time constant. The time required for a thermistor to change 63.2 percent of the total difference between its initial and final body temperature when subjected to a step function change in temperature under zero power conditions.

2.3.10 Resistance-temperature characteristic. The relationship between the zero-power resistance of a thermistor and its body temperature.

2.3.11 Temperature wattage characteristic. The relationship at a specified ambient temperature between the thermistor temperature and the applied steady state wattage.

2.3.12 Current-time characteristic. The relationship at a specified ambient temperature between the current through the thermistor and time, upon application or interruption of voltage to it.

2.3.13 Stability. The ability of a thermistor to retain specified characteristics after being subjected to designated environmental or electrical test conditions.

3. *ITEM IDENTIFICATION. (see figures 502-3 and 502-4)*

3.1 Part number designation. The part number designation is used for identifying and describing the resistor as shown in figure 502-2.

3.2 Performance characteristics. Performance characteristics are as shown in table 502-V.

3.3 Resistance values. *Resistance values shall follow the decade of values as* shown in table 502.IV.

TABLE 502-IV. Standard resistance values for the 10 to 100 decade for resistance tolerances 1, 2, 5, and 10 percent.

F (1.0) G (2.0) J (5.0)	K (10.0)	F (1.0) G (2.0) J (5.0)	K (10.0)
10	10	36	---
11	---	39	39
12	12	43	---
13	---	47	47
15	15	51	---
16	---	56	56
18	18	62	---
20	---	68	68
22	22	75	---
24	---	82	82
27	27	91	---
30	---		
33	33		

3.4 Failure rate factors. Failures are considered to be opens, starts, or radical departures from initial characteristics occurring in an unpredictable manner, and in too short of period of time to permit detection through normal preventative maintenance. Failure rate factors applicable to this specification are stated in MIL-HDBK-217. The failure rate factors stated in MIL-HDBK-217 are based on "catastrophic faiures".

TABLE 502-V. Performance characteristics.

	A	B	C	D
Maximum ambient temperature at rated wattage	25°C	25°C	25°C	25°C
Maximum ambient temperature at zero wattage derating	25°C	25°C	25°C	25°C
Dissipation factor				
RTH06	5 mW/°C	5 mW/°C	5 mW/°C	---
RTH08	10 mW/°C	10 mW/°C	10 mW/°C	---
RTH10	15 mW/°C	15 mW/°C	15 mW/°C	---
RTH22	---	---	---	5 mW/°C
RTH42	---	---	---	2.5 mW/°C
Thermal time constant				
RTH06	80 seconds	80 seconds	80 seconds	---
RTH08	250 seconds	250 seconds	250 seconds	---
RTH10	450 seconds	450 seconds	450 seconds	---
RTH22	---	---	---	60 seconds
RTH42	---	---	---	60 seconds
Power rating at 25°C				
RTH06	.5 watt	.5 watt	.5 watt	---
RTH08	1.0 watts	1.0 watts	1.0 watts	---
RTH10	1.5 watts	1.5 watts	1.5 watts	---
RTH22	---	---	---	.5 watt
RTH42	---	---	---	.25 watt
Minimum and maximum resistance values	Min / Max	Min / Max	Min / Max	Min / Max
RTH06	68 / 560	630 / 4700	7.5 kΩ / 75 kΩ	--- / ---
RTH08	27 / 180	180 / 1800	2.2 kΩ / 22 kΩ	--- / ---
RTH10	10 / 82	68 / 330	1 kΩ / 6.8 kΩ	--- / ---
RTH22	--- / ---	--- / ---	--- / ---	10 / 39 kΩ
RTH42	--- / ---	--- / ---	--- / ---	10 / 10 kΩ
Features				
Moisture resistance				
RTH06	5%	5%	5%	---
RTH08	5%	5%	5%	---
RTH10	5%	5%	5%	---
RTH22	---	---	---	5%
RTH42	---	---	---	3%
Maximum percent change in resistive values:				
Short time load	2%	2%	2%	2%
Low temperature storage	2%	2%	2%	2%
High temperature storage	1%	1%	1%	1%
Terminal strength	1%	1%	1%	1%
Resistance to soldering heat	1%	1%	1%	1%
Vibration, high frequency	2%	2%	2%	2%
Life	5%	5%	5%	5%
Thermal shock	2%	2%	2%	2%
Immersion	3%	3%	3%	3%
Shock	2%	2%	2%	2%
High temperature exposure 100	1%	1%	1%	1%
High temperature exposure 1000	2%	2%	2%	2%

RTH06 A S 102 G

STYLE: The style is identified by the symbol RTH followed by a two digit number. The letters identify general purpose thermistors and the number identifies the physical configuration.

RESISTANCE RATIO: The resistance ratio is identifed by a one letter symbol as follows:

A - - - - 19.8 ±10 percent
B - - - - 29.4 ±10 percent
C - - - - 48.7 ±10 percent
D - - - - 0.5 ±10 percent
E - - - - 0.55 ±10 percent

LEAD TYPE: The single letter identifies the lead type as follows:

S - Solderable
W - Weldable

ZERO POWER RESISTANCE: The zero power resistance at 25°C in ohms is identified by a three digit number. The first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.3 and the following example.)

EXAMPLE:

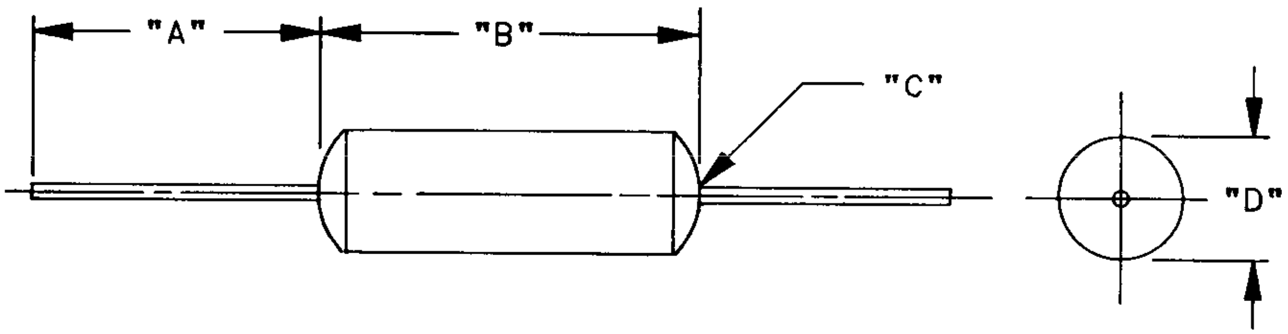
100 - - - - -	10 ohms
101 - - - - -	100 ohms
102 - - - - -	1,000 ohms
103 - - - - -	10,000 ohms
104 - - - - -	100,000 ohms

ZERO POWER RESISTANCE TOLERANCE: The single letter identifies the zero power resistance tolerance as follows:

F - - - - - ±1 percent
G - - - - - ±2 percent
J - - - - - ±5 percent
K - - - - - ±10 percent

NOTE: Tolerance at 25°C. See 2.1.3 and 2.1.4 for tolerance deviations at other temperatures.

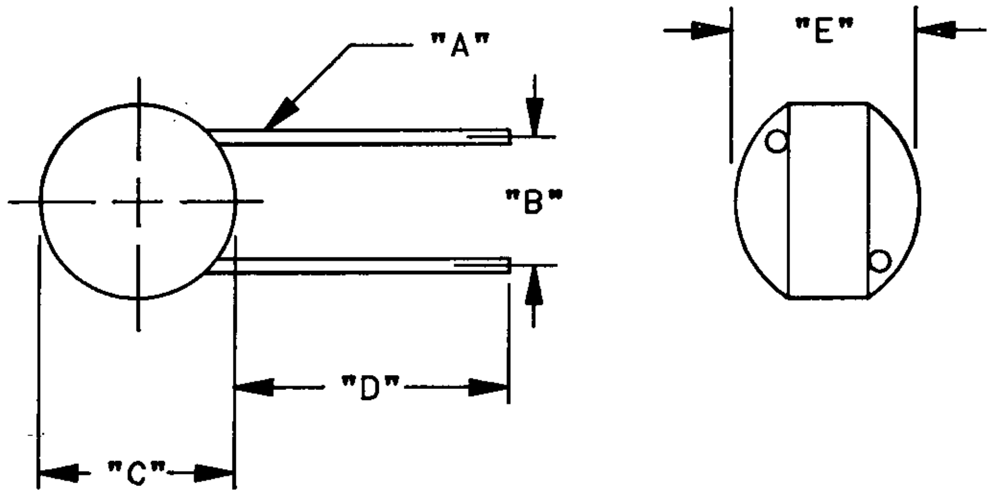
FIGURE 502-2. Part number example.



STYLE	A	B	C	D
RTH22	1.25	.41±.02	.005±.003	.14±.02
RTH42	1.20	.285±.015	.020±.003	.106±.010

NOTE:
Dimensions are in inches.

FIGURE 502-3. Thermally sensitive resistor axial lead.



Style	A	B	C	D	E
RTH06	.020 ±.003	.18	6.35	1.50	.26
RTH08	.025 ±.003	.24	11.18	1.50	.36
RTH10	.032 ±.003	.41	21.59	1.50	.45

NOTE:
Dimensions are in inches.

FIGURE 502-4. Thermally sensitive resistor radial lead.

Custodians:
Army - ER
Navy - EC
Air Force - 11

Review activities:
Army - AR, MI
Navy - AS, OS, SH
Air Force - 17, 80, 85
DLA - ES

User activities:
Army - AT, AV, ME
Navy - CG, MC
Air Force - 19

Preparing activity:
Army - ER

Agent:
DLA - ES

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-199D	RESISTORS, SELECTION AND USE OF

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
	☐ USER
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ MANUFACTURER
	☐ OTHER *(Specify)*: ______

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*