NOT MEASUREMENT SENSITIVE

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MILITARY STANDARD

RESISTORS, SELECTION AND USE OF

AMSC N/A

FSC 5905

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FORWARD

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Laboratory Command, ATTN: SLCET-R-S, Fort Monmouth, NJ 07703, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. 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

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SECTIONS

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, Navy, and 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. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

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-49462	Resistor, Fixed, Film, High Voltage, General Specification For.
MIL-R-4946S	Resistor, Fixed, Metal Element (Power Type), (Very Low Resistance Values), 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.
MIL-R-83530	Resistor, Voltage, Sensitive (Varistor, Metal-Oxide), General Specification For.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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.

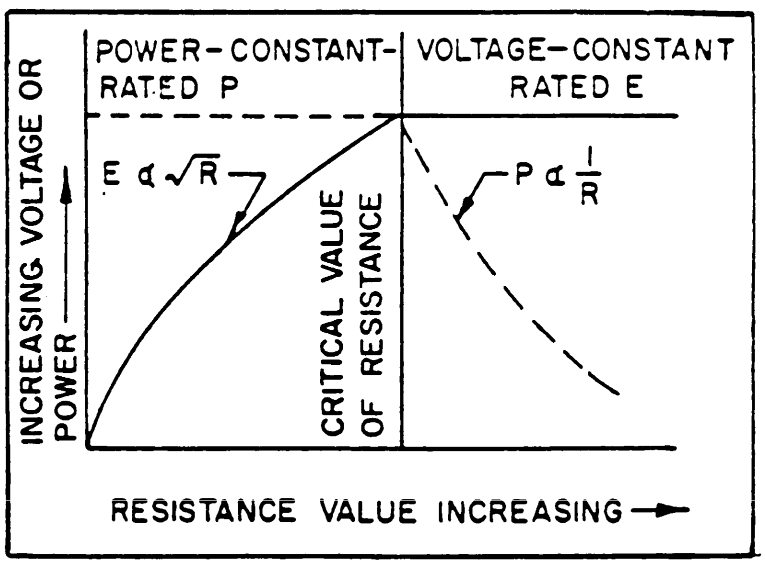


FIGURE 1. Maximum working voltage and critical value of resistance.

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 aerating 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 arts 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 described in this standard and the applicable specification, the specification shall govern; however, this standard will be updated 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 Detailed requirements. 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
Nonwirewound
Resistance-temperature characteristic
Resistor
Thermistor
Variable
Varistor
Wirewound

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

APPENDIX

GENERAL APPLICATION INFORMATION

10. SCOPE

10.1 Scope. The application information in this standard is designed to help in the selection of specified resistors (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 being designed. 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 to choose. The advantages and disadvantages should be known, their behavior under various environmental conditions, their construction, and their effect on circuits and the effect of circuits on them, and a knowledge of what makes resistors fail. 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 as 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 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.

2/ See tables on pages 21 through 27.

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.

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 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 nonwirewound (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-preclslon 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, nonwirewound. 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.

1. 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 semiprecision 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, nonwirewound (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, nonwirewound (adjustment type). Use for matching, balancing, and adjusting circuit variables in computers, telemetering equipment, and other critical applications.

u. MIL-R-49462, RHV, fixed, film, high voltage. These resistors are intended for use in electronic circuits where high voltages and high resistance values are used.

v. MIL-R-49465, RLV, fixed, metal element (power type). These resistors are for use where power type, very low resistance values are required. Values are for .1 ohm and below. These resistors are primarily for use in electrical, electronic, and communications type equipment.

w. 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)).

x. MIL-R-5534Z, 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.

y. 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.

z. 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.

aa. MIL-R-83530, RVS, voltage sensitive resistor, (varistor). These devices function as a nonlinear variable impedance dependent on voltage. They are designed to protect a circuit from a surge in voltage.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

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, 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 nonwirewound 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 volts e 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.

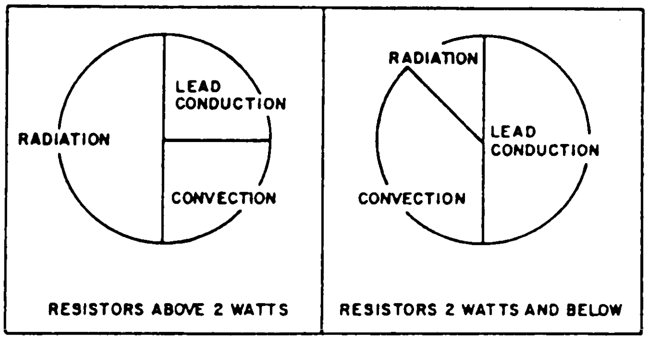


FIGURE 3. Heat dissipation of resistors under room conditions.

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 ther 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 characteristic caused by environmental stresses may be linear or nonlinear, reversible or nonreversible (permanent), or combinations thereof. Where a characteristic 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 one-third watt, do not use a one-half 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 Hz. 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 MΩ 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 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.l.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 now not 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 here in 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 0.01 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.

40.4 Cross reference. A cross reference of section number, military specification numbers, detail specification numbers, and style numbers are included for reference (see table V).

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) ohm to ohm 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
104 (MIL-R-49465)	Metal element (power type) (very low resistance values)	RLV10	5 W	5, 10	0.01 to 0.50	25 - 175	.01 .025 ±150 .025 .0499 ±125 .05 .0749 ±100 .075 .099 ±50 .1 above ±50	.999 x .406	Z
		RLV20	3 W	5, 10	0.01 to 0.10	25 - 175	.01 .0249 ±100 .025 .0499 ±100 .05 .0749 ±100 .075 .099 ±100 .1 above ±100	.906 x .343	Y
		RLV21	5 W	5, 10	0.01 to 0.10	25 - 175	.01 .0249 ±100 .025 .0499 ±100 .05 .0749 ±100 .075 .099 ±100 .1 above ±100	.906 x .374	Y
		RLV22	7 W	5, 10	0.01 to 0.1	25 - 175	.01 .0249 ±225 .025 .0499 ±225 .05 .0749 ±250 .075 .099 ±200 .1 above ±175	1.421 x .374	Y
		RLV23	10 W	5, 10	0.01 to 0.1	25 - 175	.01 .0249 ±300 .025 .0499 ±300 .05 .0749 ±250 .075 .099 ±250 .1 above ±200	1.906 x .374	Y
		RLV30	3 W	5, 10	0.01 to 0.2	25 - 175	.01 .0249 ±350 .025 .0499 ±200 .05 .0749 ±125 .075 .099 ±75 .1 above ±50	.622 x .263	A
		RLV31	5 W	5, 10	0.01 to 0.3	25 - 175	.01 .0249 ±250 .025 .0499 ±150 .05 .0749 ±100 .075 .099 ±75 .1 above ±50	.987 x .361	A

See footnotes at end of table.

TABLE I. Fixed resistor selection guidance table - Continued.

Section	Type	Styles avail-able in standard	Power and max voltage ratings	Resistance tolerance (± percent)	Ohmic range	Temperature range (°C) 1/	Resistance temperature coefficient (ppm/°C) ohm to ohm PPM/C°	Max body size (inches)	Configuration (see fig. 4)
104 (MIL-R-49465)	Metal element (power type) (very low resistance values)	RLV32	10 W	5, 10	0.01 to 0.8	25 - 175	.01 .0249 ±350 .025 .0499 ±200 .05 .0749 ±150 .075 .099 ±75 .1 above ±75	1.842 x .476	A
		RLV40	3 W	5, 10	0.01 to 0.1	25 - 175	.01 .0249 ±200 .025 .0499 ±200 .05 .0749 ±150 .075 .099 ±150 .1 above ±100	.937 x .343	A
		RLV41	5 W	5, 10	0.01 to 0.1	25 - 175	.01 .0249 ±200 .025 .0499 ±200 .05 .0749 ±150 .075 .099 ±150 .1 above ±100	.937 x .374	A
		RLV42	7 W	5, 10	0.01 to 0.1	25 - 175	.01 .0249 ±300 .025 .0499 ±300 .05 .0749 ±200 .075 .099 ±200 .1 above ±100	1.452 x .374	A
		RLV43	10 W	5, 10	0.01 to 0.1	25 - 175	.01 .0249 ±400 .025 .0499 ±400 .05 .0749 ±350 .075 .099 ±300 .1 above ±100	1.937 x .374	A
105 (MIL-R-49462)	Fixed, film, high voltage	RHV30	.25 W/750 V	1.0,2.0,5.0	100 k to 100 MΩ	70 - 175	< 500 MΩ = 200 ppm	0.306 x .098	A
		RHV31	.5 W/1.5 kV	"	100 k to 3.92 MΩ	"	≥ 500 MΩ = 500 ppm	0.431 x 0.154	"
		RHV32	1.0 W/3.0 kV	"	100 k to 499 MΩ	"	"	0.752 x 0.328	"
		RHV33	2.0 W/5.0 kV	"	100 k to 499 MΩ	"	"	1.124 x 0.328	"
		RHV34	3.0 W/10.0 kV	"	200 k to 1 GΩ	"	"	2.124 x 0.328	"
		RHV35	5.0 W/20.0 kV	"	300 k to 1 GΩ	"	"	3.124 x 0.328	"
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

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)
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	"
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 .161	"
		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), ±30 (R≥20Ω)	.662 x .677 x .351	F
		RER45	10 W 2/	"	1 to 2.80 kΩ	"	"	.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 .656	"
		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 .656	"
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 - +175	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 - 150	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 - 125	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 - 150	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 - 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	10Ω 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

See footnotes at end of table.

TABLE II. Special fixed resistor selection guidance table - Continued.

Section	Type	Styles available in standard	PIN	Voltage rating (V)	Energy rating (joules)	Clamping voltage at 100A (V)	Tolerance (%)	Capacitance at 1 MHz (pF)	Clamping voltage at peak current rating (6000A) (V)	Max body size (inches)	Configuration (see figure 4)
503 (MIL-T-83530)	Varistor	RVS10	M83530/1-2000B	rms 130, dc 175	70	325	±10	3800	570	1.10 x .95 x .32	W
		RVS10	M83530/1-2200D	150 200	80	360	±10, -5	3200	650	1.10 x .95 x .32	W
		RVS10	M83530/1-4300E	275 369	140	680	+5, -10	1800	1200	1.10 x .95 x .32	W
		RVS10	M83530/1-5100E	320 420	160	810	+5, -10	1500	1450	1.10 x .95 x .32	W

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
		RV8	.5, .25	A, C	100 to 5 MΩ	70 - 120		1.188 x .520	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)	Nonwirewound (adjustment type)	RJ24	.5		10 to 1 MΩ	85 - 150	±100, ±250	.375 x .375 x .150	K
208 (MIL-R-23285)	Nonwirewound	RVC6	.5	A, C	100 to 2.5 MΩ	125 - 175	±250	.516 x .469	J
209 (MIL-R-39023)	Nonwirewound, 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)	Config- uration (see fig. 4)
401 (MIL-R-39015)	Wirewound (lead-screw actuated), established reliability	RTR12 RTR22 RTR24	.75 .75 .75		10 to 10 kΩ 10 to 10 kΩ 10 to 5 kΩ	85 - 150 " "	±50 " "	1.260 x .200 x .330 .510 x .197 x .510 .390 x .245 x .390	L K K
402 (MIL-R-39035)	Nonwirewound (adjustment type), established reliability	RJR12 RJR24 RJR26 RJR28 RJR50	.75 .5 .25 .3 .25		10 to 1 MΩ 10 to 1 MΩ 50 to 1 MΩ 100 to 2 MΩ 10 to 1 MΩ	85 - 150 " " " "	±50, ±100, ±250 " " " "	1.260 x .330 x .200 .390 x .195 x .420 .270 x .195 x .270 .510 x .110 x .180 .270 x .270 x .250	L K K L 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 number	Military specification	Military type	Equivalent NATO style	NEPR number
Fixed resistors							
MIL-R-26 (see section 101)	RW29 RW31 RW33 RW35 RW37 RW38 RW47 RW56	NRW01 NRW02 NRW03 NRW04 NRW05 NRW06 NRW07 NRW09	5 " " " " " " "	MIL-R-55182 (see section 302 - continued)	RNR65H RNR65J RNR65K RNR70E RNR70H RNR70J RNR70K	NRN02 NRN34 NRN54 NRN45 NRN03 NRN35 NRN55	6 " " " " " "
MIL-R-39008 (see section 301)	RCR05 RCR07 RCR20 RCR32 RCR42	NRC06 NRC02 NRC03 NRC04 NRC05	2 " " " "	MIL-R-39005 (see section 303)	RBR52 RBR53 RBR54 RBR55 RBR56 RBR57 RBR71	NRB10 NRB09 NRB08 NRB07 NRB19 NRB18 NRB14	8 " " " " " "
MIL-R-55182 (see section 302)	RNR50H RNR50J RNR50K RNR55E RNR55H RNR55J RNR55K RNR60E RNR60H RNR60J RNR60K RNR65E	NRN22 NRN31 NRN51 NRN42 NRN21 NRN32 NRN52 NRN43 NRN01 NRN33 NRN53 NRN44	6 " " " " " " " " " " "	MIL-R-39007 (see section 304)	RWR78 RWR80 RWR81 RWR84 RWR89	NRW53 NRW54 NRW55 NRW56 NRW57	72 " " " "
				MIL-R-39017 (see section 305)	RLR05C RLR07C RLR20C RLR32C RLR42C	NRC16 NRC11 NRC12 NRC13 NRC15	4 " " " "
Variable resistors							
MIL-R-94 (see section 201)	RV4S RV4T RV6S RV6T	NRV06 NRV20 NRV10 NRV21	10 " " "	MIL-R-22 (see section 203)	RP05 RP06 RP10 RP15 RP20 RP25 RP30	NRP08 NPR07 NRP02 NRP03 NRP04 NRP05 NRP06	11 " " " " " "
MIL-R-19 (see section 202)	RA20 RA30	NRA08 NRA10	9 "				

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	RK11	3	MIL-R-39002	205
RA20	2	"	"	RLR05	5	MIL-R-39017	305
RA30	3	"	"	RLR07	1	"	"
RBR52	1	MIL-R-39005	303	RLR20	2	"	"
RBR53	2	"	"	RLR32	3	"	"
RBR54	3	"	"	RL42..TX	8	MIL-R-22684	102
RBR55	4	"	"	RLV10	1	MIL-R-49465	104
RBR56	5	"	"	RLV20	2	"	"
RBR57	7	"	"	RLV21	3	"	"
RBR71	6	"	"	RLV22	4	"	"
RBR74	8	"	"	RLV23	5	"	"
RBR75	9	"	"	RLV30	6	"	"
RBR76	10	"	"	RLV31	7	"	"
RBR80	11	"	"	RLV32	8	"	"
RBR81	11	"	"	RLV40	9	"	"
RCR05	4	MIL-R-39008	301	RLV41	10	"	"
RCR07	1	"	"	RLV42	11	"	"
RCR20	2	"	"	RLV43	12	"	"
RCR32	3	"	"	RM0502	1	MIL-R-55342	307
RCR42	5	"	"	RM0505	2	"	"
RER40	2	MIL-R-39009	306	RM1005	3	"	"
RER45	2	"	"	RM1505	4	"	"
RER50	2	"	"	RM2208	5	"	"
RER55	2	"	"	RM0705	6	"	"
RER60	1	"	"	RNC50	7	MIL-R-55182	302
RER65	1	"	"	RNC55	1	"	"
RER70	1	"	"	RNC60	3	"	"
RER75	1	"	"	RNC65	5	"	"
RE77	2	MIL-R-18546	103	RNC70	6	"	"
RE80	2	"	"	RNC75	10	"	"
RFP01	1	MIL-R-122	308	RNC90	9	"	"
RFP03	3	"	"	RNR50	7	"	"
RFP06	6	"	"	RNR55	1	"	"
RFP10	10	"	"	RNR60	3	"	"
RHV30	3	MIL-R-49462	105	RNR65	5	"	"
RHV31	3	"	"	RNR70	6	"	"
RHV32	3	"	"	RNR75	10	"	"
RHV33	3	"	"	RP05	15	MIL-R-22	203
RHV34	3	"	"	RP06	1	"	"
RHV35	3	"	"	RP07	2	"	"
RJR12	1	MIL-R-39035	402	RP10	3	"	"
RJR24	2	"	"	RP11	4	"	"
RJR26	3	"	"	RP15	5	"	"
RJR28	5	MIL-R-39035	402	RP16	6	"	"
RJR50	4	"	"	RP20	7	"	"
RK09	1	MIL-R-39002	205	RP25	8	"	"

APPENDIX

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-R-23285	208
RQ210	8	"	"	RVS10	1	MIL-R-83530	503
RQ300	5	"	"	RV2	4	MIL-R-94	201
RR0900	1	MIL-R-12934	204	RV4	5	"	"
RR1000	6	"	"	RV5	2	"	"
RR1004	34	"	"	RV6	3	"	"
RR1100	2	"	"	RV8	7	"	"
RR1300	19	"	"	RWR78	7	MIL-R-39007	304
RR1400	20	"	"	RWR80	8	"	"
RR2000	4	"	"	RWR81	9	"	"
RR2002	33	"	"	RWR82	12	"	"
RR2100	9	"	"	RWR84	10	"	"
RR2104	35	"	"	RWR89	11	"	"
RR3000	5	"	"	RW29	3	MIL-R-26	101
RR3100	10	"	"	to 39			
RR3200	15	"	"	RW47	3	"	"
RR3300	16	"	"	RW56	4	"	"
RR3400	17	"	"	RZ010	1	MIL-R-83401	501
RR3500	18	"	"	RZ020	2	"	"
RR3600	27	"	"	RZ030	3	"	"
RR3601	36	"	"	RZ040	4	"	"
RR3700	28	"	"	RZ050	5	"	"
RR3800	29	"	"	RZ060	6	"	"
RR3900	30	"	"	RZ070	7	"	"
				RZ080	8	"	"
				RZ090	9	"	"
				2RV7	6	MIL-R-94	201

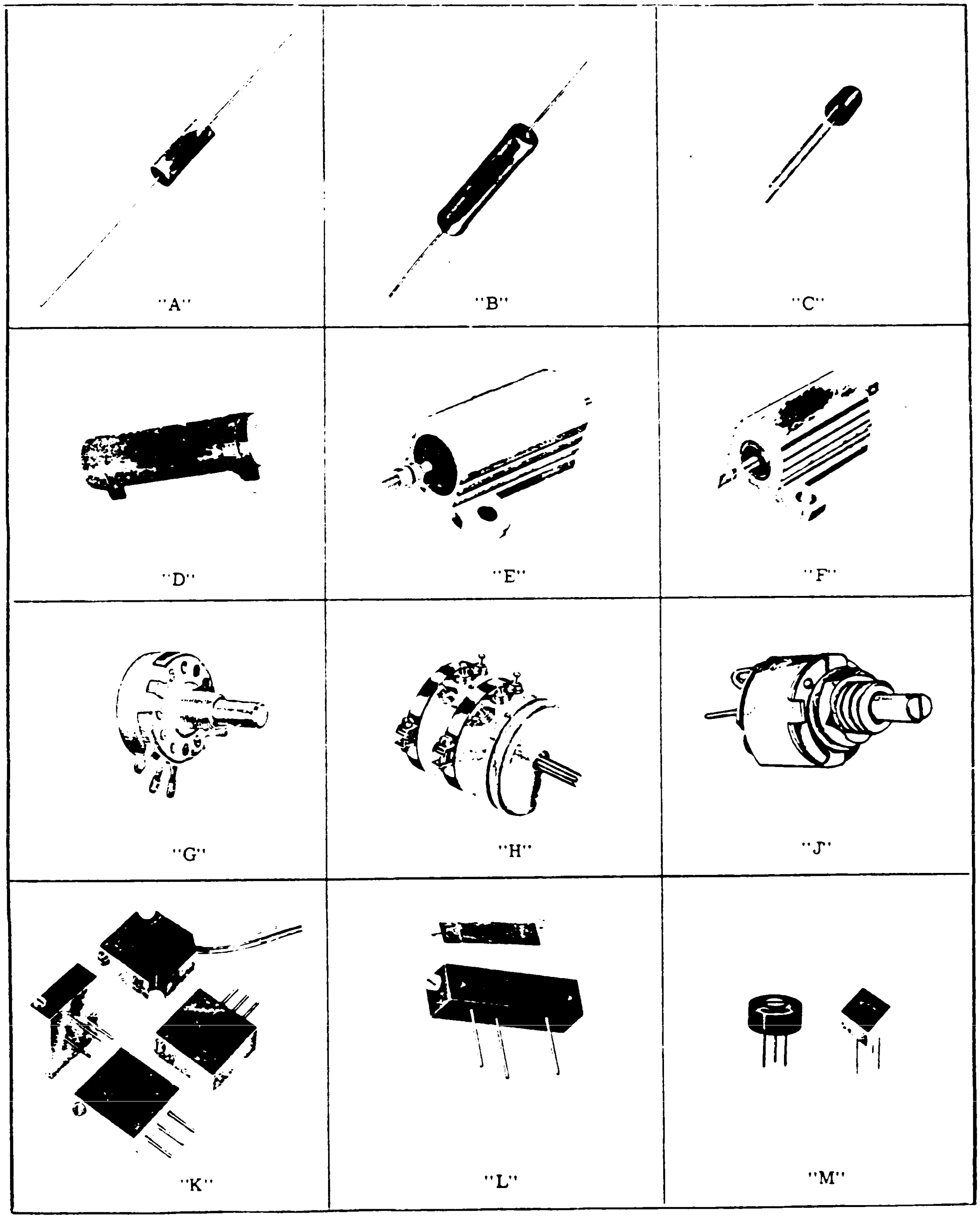


FIGURE 4. Configurations.

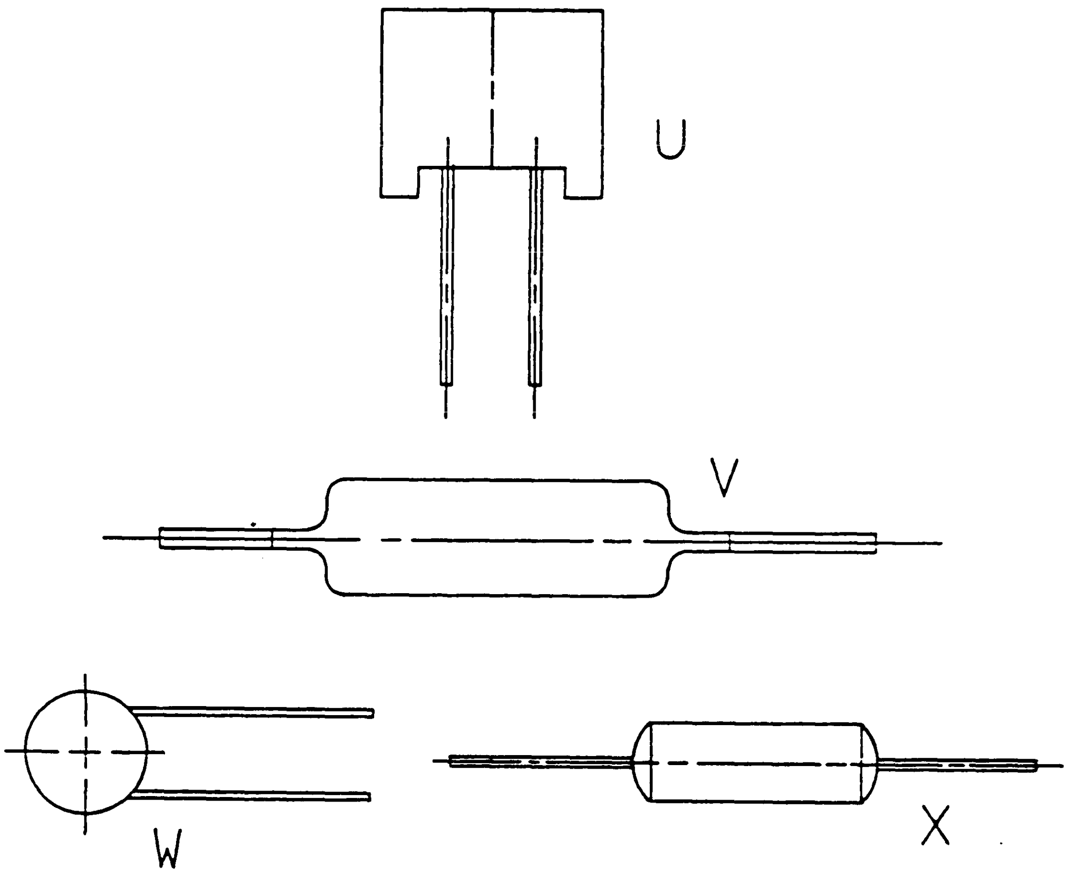


FIGURE 4. Configurations - Continued.

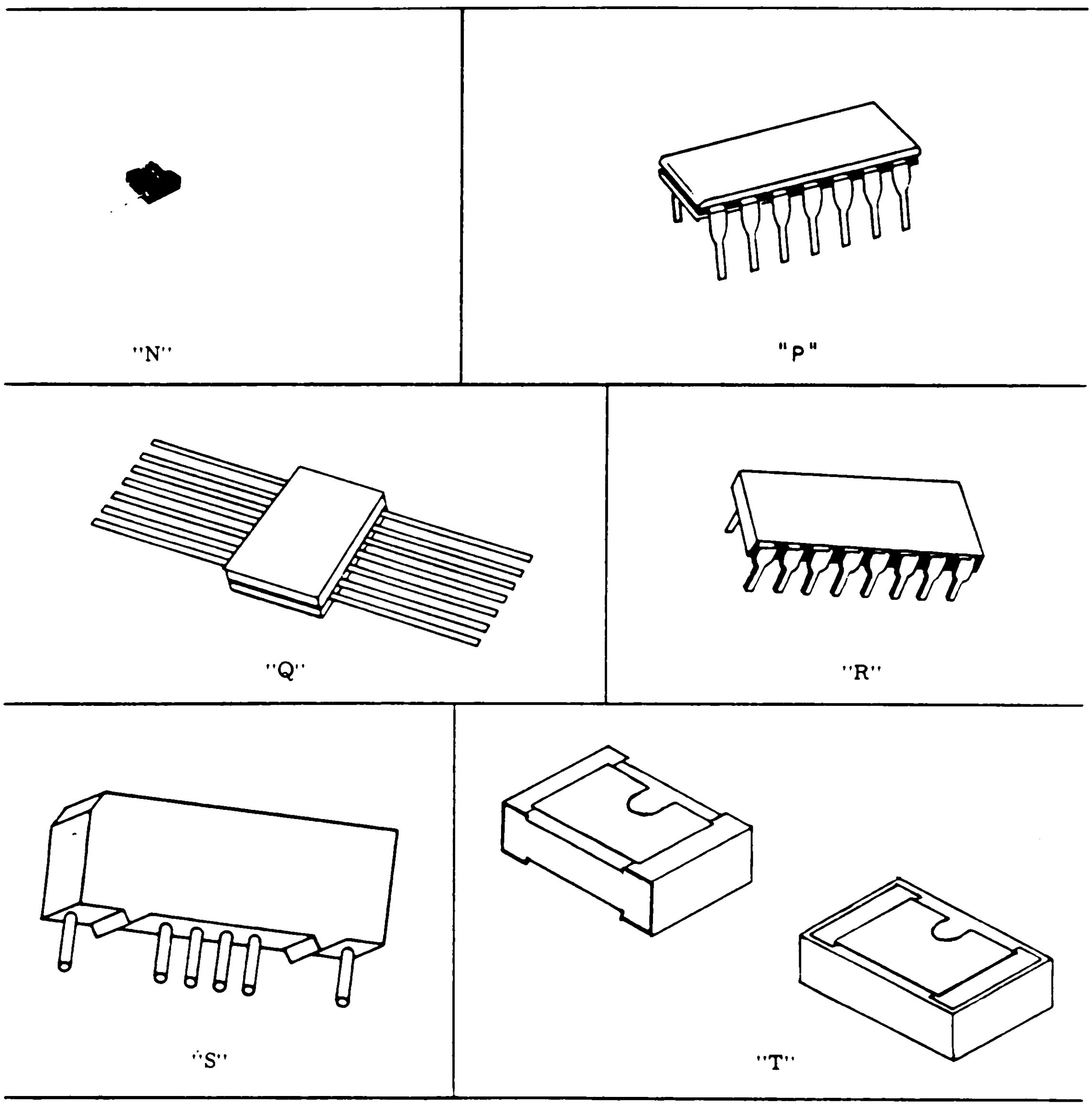
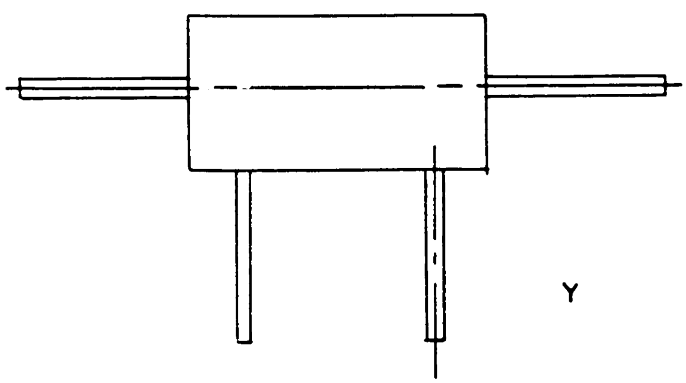


FIGURE 4. Configurations - Continued.



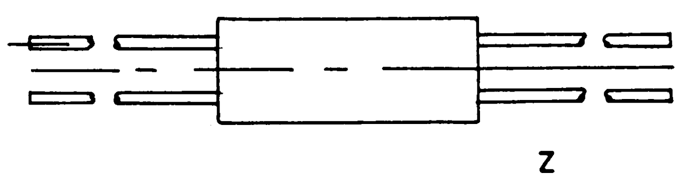


FIGURE 4. Configurations - Continued.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 85

Review activities:
Army - AR, MI
Navy - AS, OS, SH
Air Force - 17, 80
DLA - ES

User activities:
Army - AT, AV, ME
Navy - CG, MC
Air Force - 19

Preparing activity:
Army - ER

Agent:
DLA - ES

(Project 5905-1220)

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

1.1 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 (charteristics 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.

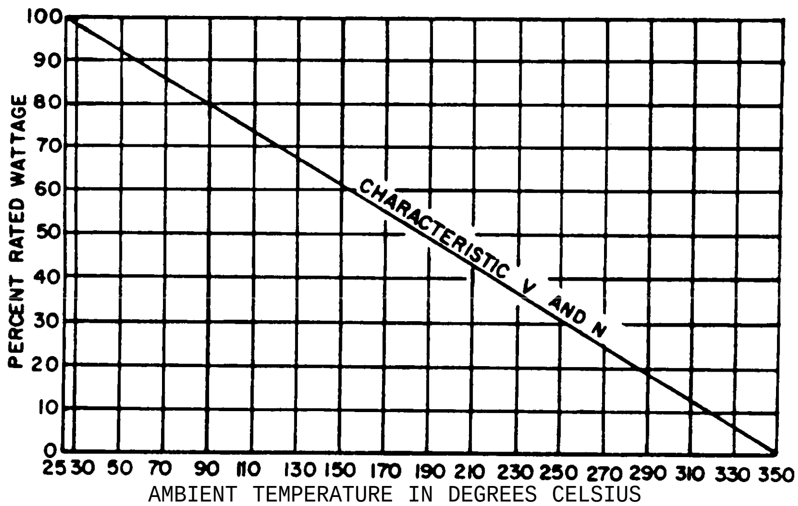


FIGURE 101-1. Derating curve for high ambient temperature.

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 two, 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, .250 inch or less preferred, but not longer than .625 inch. The longer the lead, the more likely that a mechanical failure will occur. For mounting of tab-terminal resistors, use bracket assembles specified on MS75009. Figure 101-2 provides an outline of these assembles; see MS sheet for detailed information.

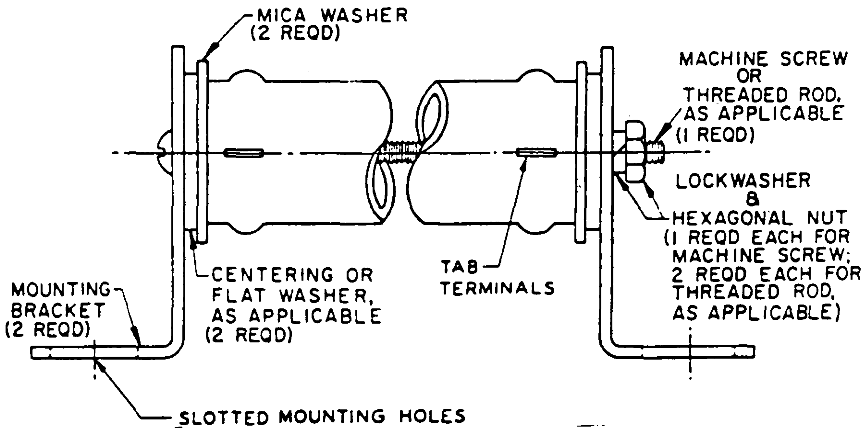


FIGURE 101-2. Bracket assembly.

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.

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.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 101-1.

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).

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 (see note) +350°C max oper temp; min IR of 100 MΩ;
N (see note) ppm/°C = +650(R ≥ .1 ≤ .449Ω), +500 (R<.499 <1Ω), +400 (R>1<10Ω), ±400 (R>10<20Ω), -200 ±260 (R > 20 Ω)

NOTE: V indicates inductively wound resistors; N indicates noninductively wound resistors.

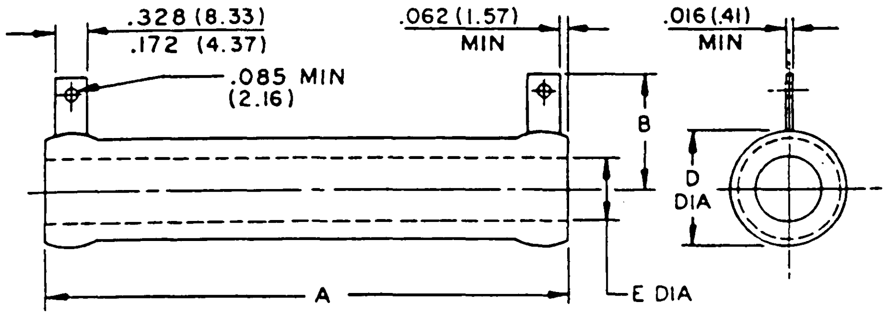
Resistance: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. For values less than 10 ohms, all digits are significant with the letter "R" representing the decimal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

Example:

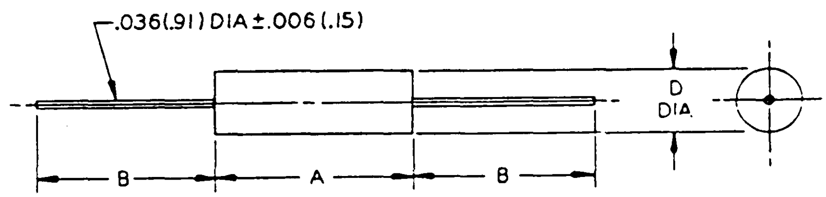
R10- - - - -	0.1 ohm
1R0- - - - -	1.0 ohm
101- - - - -	100 ohms
102- - - - -	1,000 ohms

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.



Styles RW29 to RW47 inclusive.



Style RW56.

Inches	mm
.016	0.41
.031	0.79
.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	(see note) E
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	---

For styles RW35, RW37, RW38, and RW47, dimension "E" applies for at least .500 (12.70 mm) from each end of the tube; the remainder of the core is not less than .250 (6.35 mm) in diameter.

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

TABLE 101-1. 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 hour	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).

MIL-STD-199E

SECTION 102

RESISTORS, FIXED, FILM, INSULATED

STYLE RL42 . . . . . TX

(APPLICABLE SPECIFICATION: MIL-R-22684)

1. SCOPE

1.1 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.

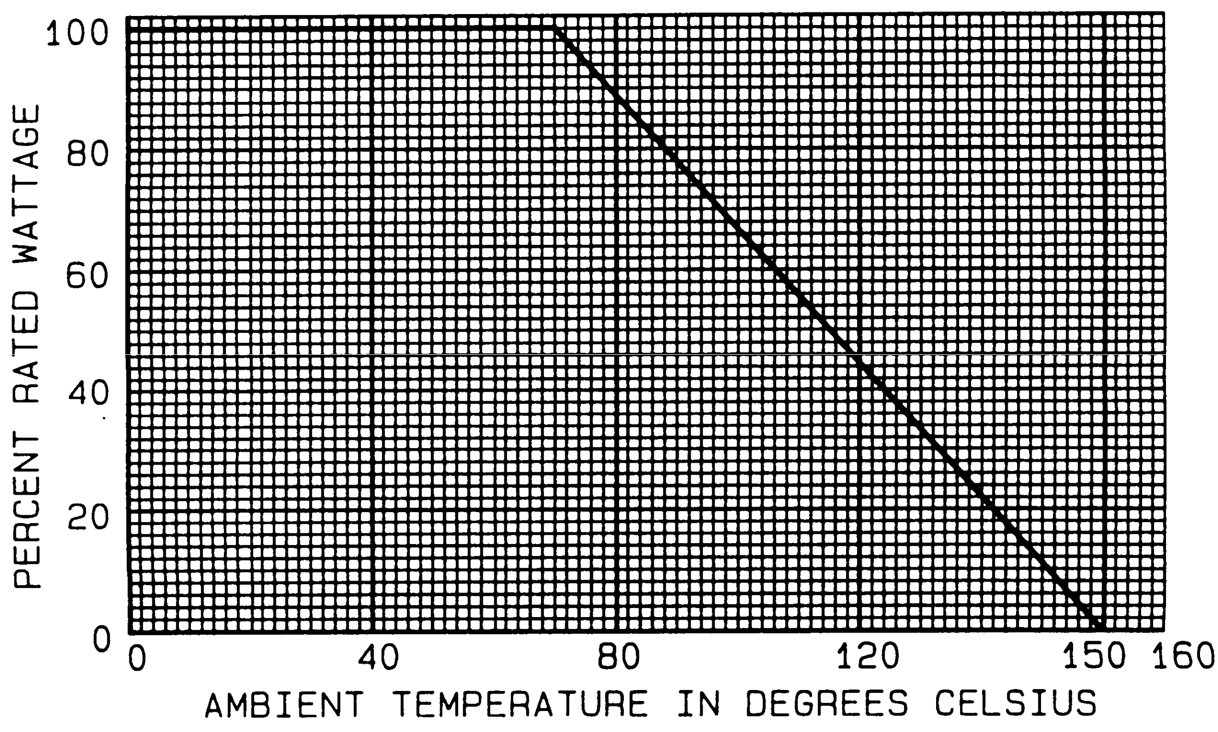


FIGURE 102-1. Derating curve for high ambient temperature.

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 or Identifying Number (PIN). The PIN is used for identifying the resistor as shown on figure 102-2.

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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 in accordance with figure 102-3.

FIGURE 102-2. PIN example.

3.2 Type designation (for reference only). The type designation is used for describing the resistor as shown on 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. PIN designation.

Dash number resistance G	Dash number tolerance J	Nominal total resistance	Type designation 1/	Dash number resistance G	Dash number tolerance J	Nominal total resistance	Type designation 1/
		Ohms				Ohms	
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				

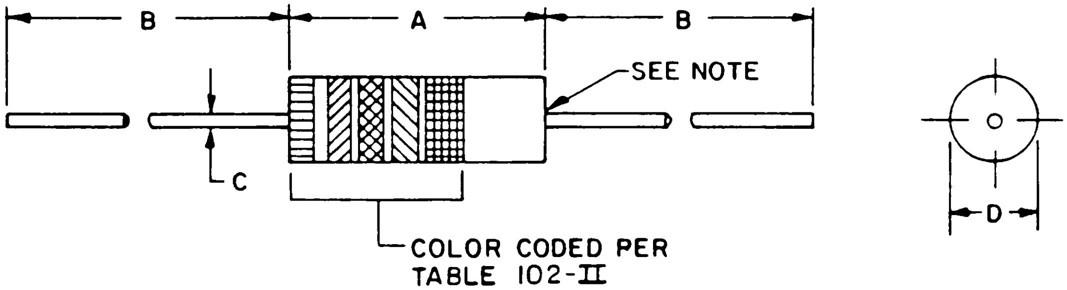
See footnote at end of table.

TABLE 102-I. PIN designation - Continued.

Dash number resistance tolerance G	J	Nominal total resistance	Type designation 1/	Dash number resistance tolerance G	J	Nominal total resistance	Type designation 1/
		Ohms				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
.280	7.11
.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	.280	.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 (3.18 mm) of the resistor body.

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

TABLE 102-II. Color code for film-type resistors. 1/

Band A 2/		Band B 3/		Band C 4/		Band D 5/		Band E 6/	
Color	First significant number	Color	Second significant number	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/ 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.

2/ The first significant number of the resistance value.

3/ The second significant number of the resistance value.

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

5/ The resistance tolerance.

6/ Indicates a solderable terminal and is the “TX” indicator band (This band is approximately 1.500 times the width of other bands.).

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

TABLE 102-III. Performance characteristics. 1/

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 2/:	
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/ All leads are solderable in accordance with method 208 of MIL-STD-202.
2/ Where total resistance change is 1 percent or less, it shall be considered as ± (percent + 0.05 ohm).

SECTION 103

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

STYLES RE77 AND RE80

(APPLICABLE SPECIFICATION: MIL-R-18546)

1. SCOPE

1.1 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 debating.)

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 two 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.

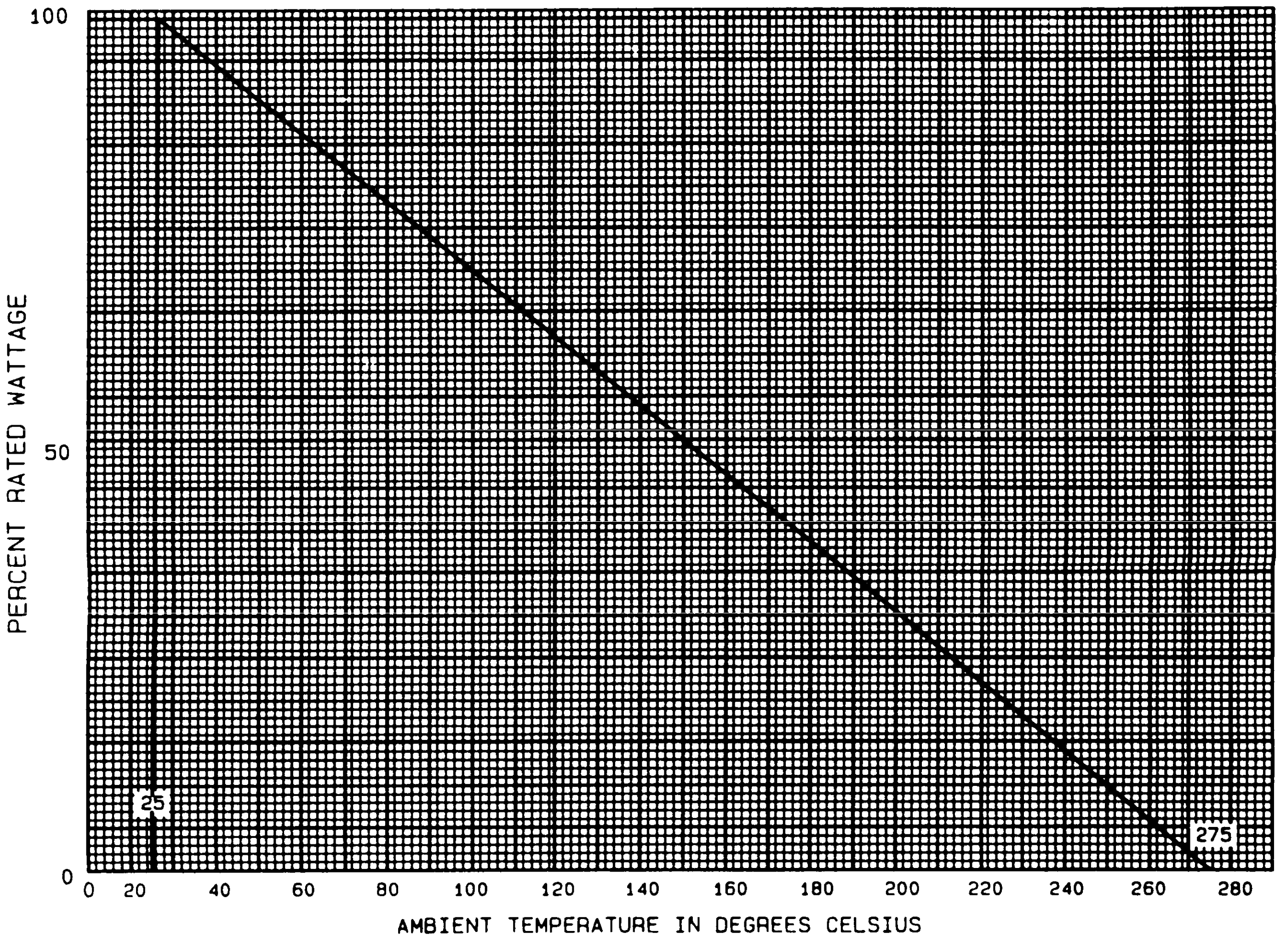


FIGURE 103-1. Derating curve for high ambient temperature.

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 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.

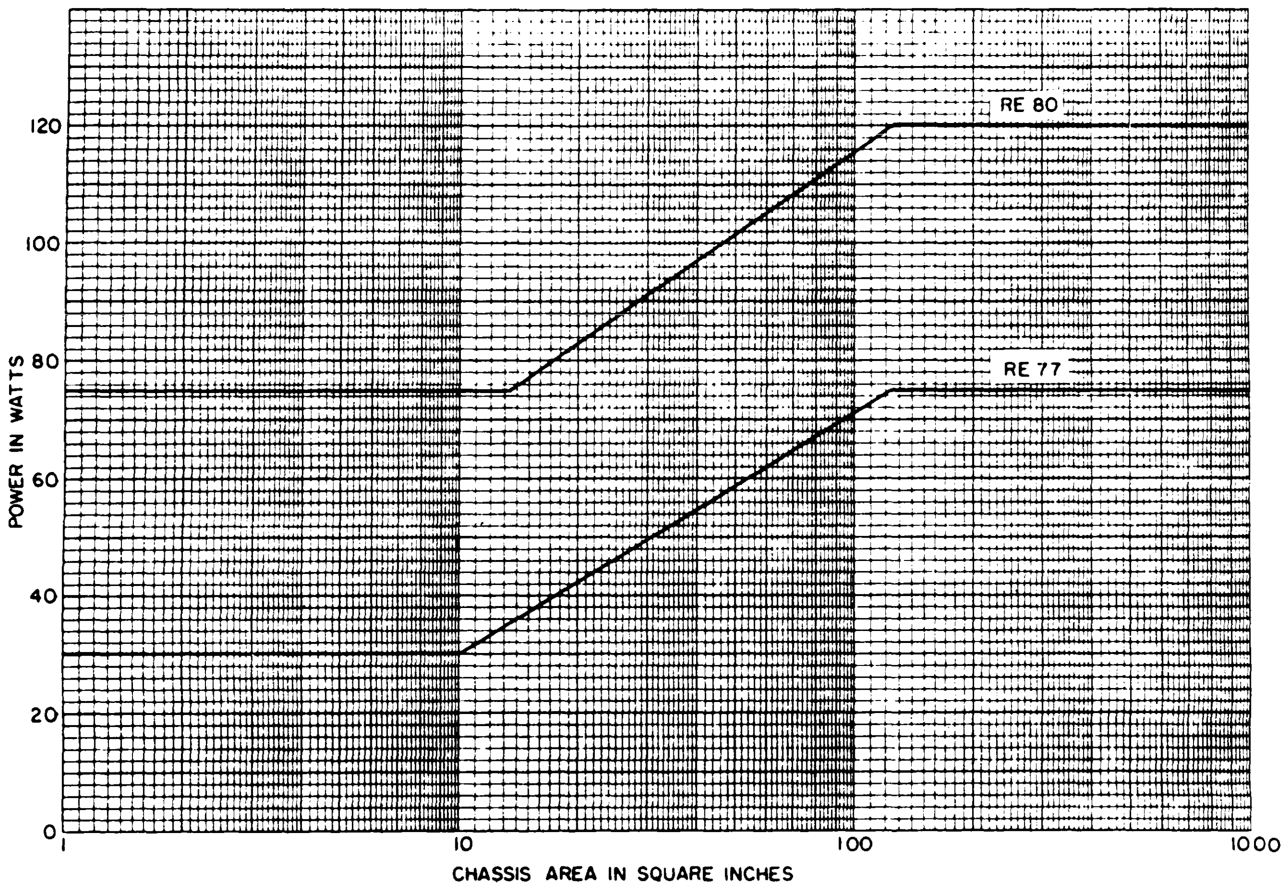


FIGURE 103-2. Chassis area derating curves.

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 foil owing:

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	70.00
11.00	16.50	24.30	35.70	50.00	71.50
11.30	16.90	24.90	---	51.10	73.20
11.50	17.40	25.50	36.50	52.30	75.00
11.80	17.80	26.10	37.40	53.60	76.80
---	---	26.70	38.30	54.90	78.70
12.10	18.20	---	---	---	80.00
12.40	18.70	27.40	39.20	56.20	80.60
12.70	19.10	28.00	40.20	57.60	82.50
13.00	19.60	28.70	41.20	59.00	84.50
13.30	20.00	29.40	42.20	60.00	86.60
13.70	20.50	---	---	60.40	88.70
14.00	21.00	30.10	43.20	61.90	90.90
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
					99.00

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).

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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:

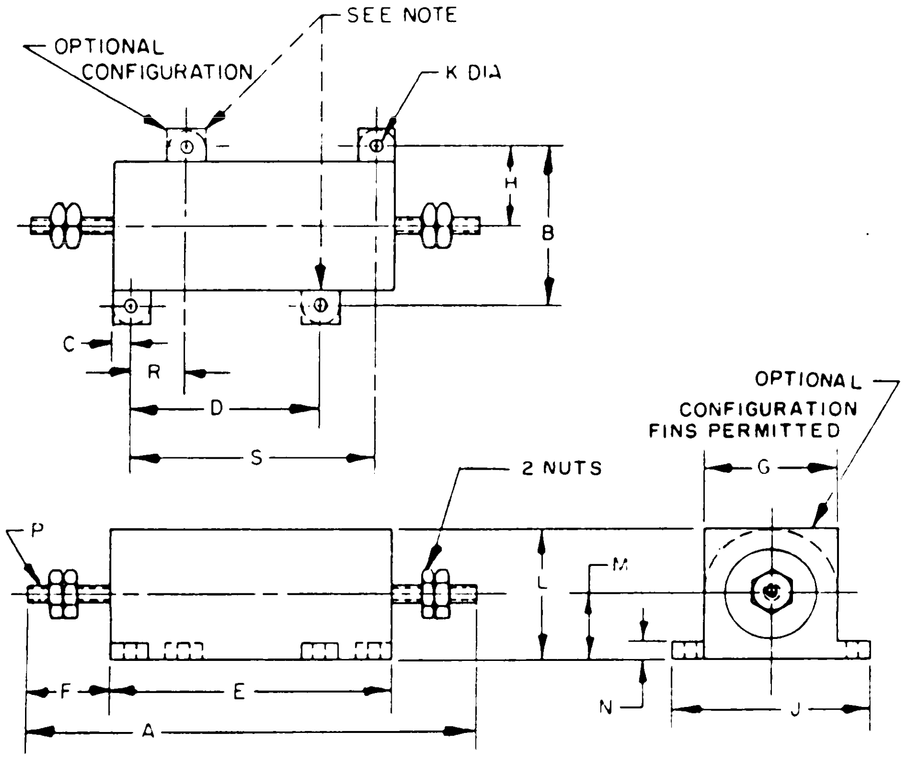
G (inductively wound) _ _ _ +275°C max. cont. oper. temp.
N (noninductively wound)

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:

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

FIGURE 103-3. Type designation example.



Inches	mm
.010	0.05
.015	0.38
.031	0.79
.062	1.57
.094	2.39
.125	3.18
.188	4.78
.250	6.35
.312	7.92
.375	9.53
.770	19.56
.875	22.23
.989	25.12
1.000	25.40
1.125	28.58
1.250	31.75
1.750	44.45
1.812	46.02
2.125	53.98
2.188	55.58
2.250	57.15
2.500	63.50
2.750	69.85
2.812	71.42
3.000	76.20
3.500	88.90
3.875	98.43
4.500	114.30
5.478	139.14
7.000	177.80

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 R ≥ 2,000 ohms	30 50	30 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 -.50	10, +0 -.50

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 104

RESISTORS, FIXED, METAL ELEMENT (POWER TYPE),
(VERY LOW RESISTANCE VALUES),

STYLES RLV10, RLV20, RLV21, RLV22, RLV23, RLV30,
RLV31, RLV32, RLV40, RLV41, RLV42, AND RLV43

(APPLICABLE SPECIFICATION: MIL-R-49465)

1. SCOPE

1.1 Scope. This specification covers the general requirements for power type, low value (1 omh and below); fixed resistors (2 terminal and 4 terminal) for use in electrical, electronic, communications, and associated equipment. Included are precision resistors of 1, 3, and 5 percent (characteristics T) and 5 and 10 percent (characteristic L) initial resistance tolerances with power ratings ranging from 2 to 10 watts at +25°C derated to 0 power at +275°C.

2. APPLICATION INFORMATION

2.1 Style selection.

2.1.1 Construction. Internal construction consists of metallic a resistive element which has no joints, welds, or bonds, except at end terminals where welding, brazing, or silver solder only is employed. The assembly is a moisture-resistant insulating material which completely encapsulates the resistive element. The encapsulation provides protection against high humidity environments with a minimum of leakage paths between terminations.

2.1.2 Power rating. These resistors, have a power rating based on continuous full load operation at an ambient temperature of +25°C. If the resistors are to be operated at temperatures exceeding +25°C, the resistor must be derated in accordance with figure 104-1.

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

2.1.4 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 execess 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, of 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.

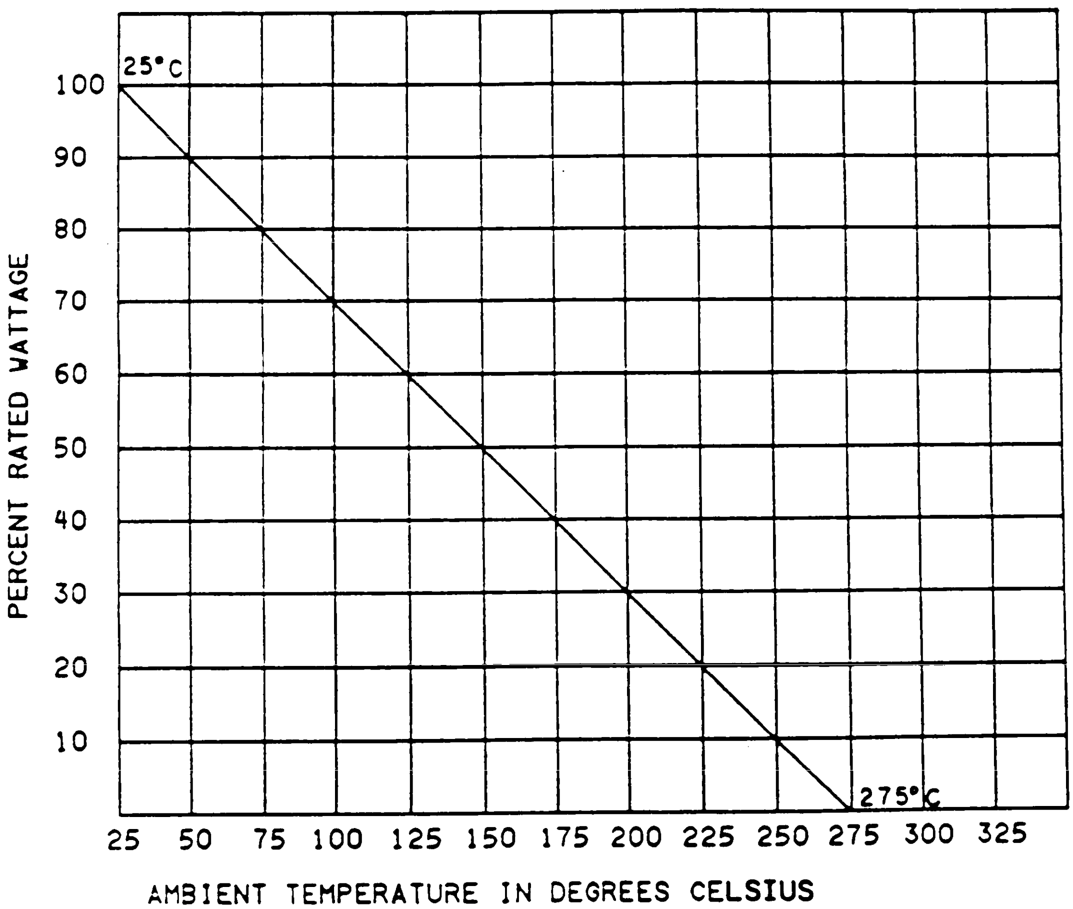


FIGURE 104-1. Derating curve for high ambient temperature.

2.2 Spacing. When resistors are mounted in rows or in 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.

2.3 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, .250 inch or less perferred, but no longer than .625 inch. The longer the lead, the more likely that a mechanical failure will occur.

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

Style	Maximum weight lbs (grams)
RLV10	.014 (6.35)
RLV20	.011 (5.0)
RLV21	.013 (5.9)
RLV22	.018 (8.2)
RLV23	.029 (13.2)
RLV30	.005 (2.0)
RLV31	.01 (5.0)
RLV32	.03 (13.6)
RLV40	.01 (5.0)
RLV41	.012 (5.4)
RLV42	.017 (7.7)
RLV43	.028 (12.7)

3. ITEM IDENTIFICATION (see figures 104-2 and 104-3).

3.1 Type designation. Type designation is used for identifying and describing the resistor as shown on figure 104-2.

3.2 Performance characteristics. Performance characteristics are shown in table 104-11.

3.3 Resistance values. Resistance values for tolerances F(l.0), H(3.0), J(5.0), and K(10.O) shall follow table 104-1

M4946501 T R0100 F

Specification number: The number identifies the detail specification number (indicating MIL-R-49465/01).

Characteristic: The single letter identifies he characteristic. Characteristics T and L are available.

Resistance: The nominal resistance expressed in ohms is identified by five digits. The letter "R" shall be substituted for one of the significant digits to represent the decimal point. The standard resistance values for each decade are listed in table 104-I.

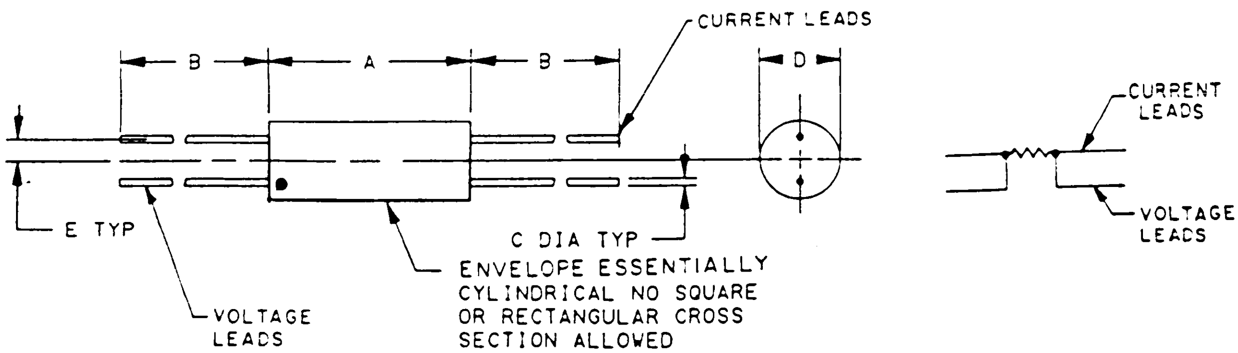
Example:

R0100 - - - - - .01 ohm
R1000 - - - - - .10 ohm

Resistance tolerance: The single letter symbol Identifies the resistance tolerance as follows:

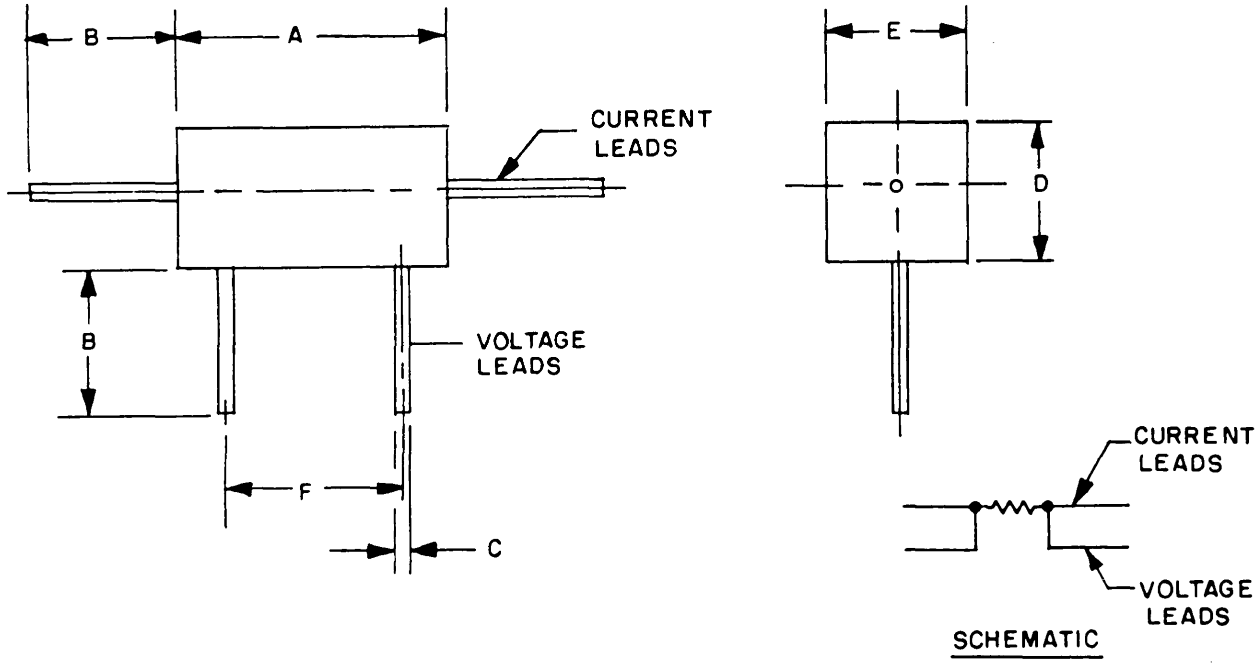
F- - - - - - - - ±1.0 percent
H- - - - - - - - ±3.0 percent
J - - - - - - - - - ±5.0 percent
K- - - - - - - - ±10.0 percent

FIGURE 104-2. Type designation.



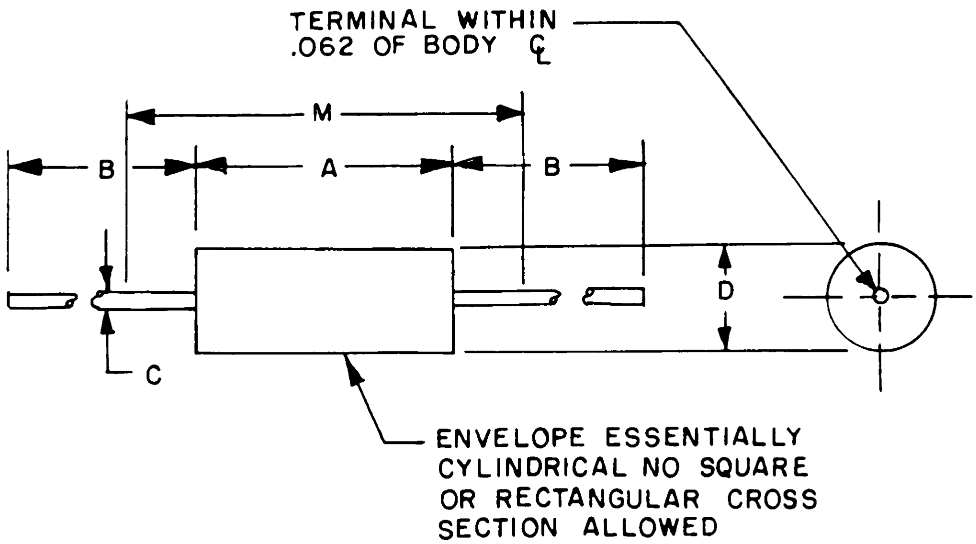
Style	Maximum weight pounds (grams)	Dimensions				
		A ±.062 (±1.57)	B Min.	C ±.002 (±.050)	D ±.031 (±.787)	E ±.020 (±.508)
RLV10	.014 (6.35)	.937 (23.80)	1.43 (37.59)	.040 (1.02)	.375 (9.53)	.062 (1.57)

FIGURE 104-3. Resistor style.



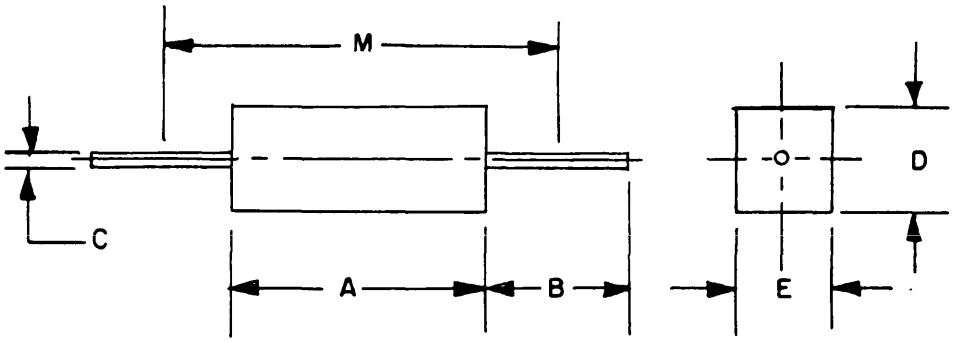
Style	Maximum weight pounds (grams)	Dimensions					
		A ±.031 (±.787)	B Min.	C ±.002 (±.050)	D ±.031 (±.787)	E ±.031 (±.787)	F ±0.60 (±.152)
RLV20	.011 (5.0)	.875 (22.23)	1.00 (25.4)	.036 (.914)	.312 (7.92)	.312 (7.92)	.562 (14.27)
RLV21	.013 (5.9)	.875 (22.23)	1.00 (25.4)	.036 (.914)	.343 (8.71)	.375 (9.53)	.562 (14.27)
RLV22	.018 (8.2)	1.390 (35.31)	1.00 (25.4)	.036 (.914)	.343 (8.71)	.375 (9.53)	1.000 (25.4)
RLV23	.029 (13.2)	1.875 (47.63)	1.00 (25.4)	.036 (.914)	.343 (8.71)	.375 (9.53)	1.375 (34.93)

FIGURE 104.3. Registor style - continued.



Style	Maximum weight pounds (grams)	Dimensions				
		A ±.062 (±1.57)	B Min.	C ±.002 (±.050)	D ±.031 (±.787)	M ±.031 (±.787)
RLV30	.005 (2)	.560 (14.22)	1.500 (38.1)	.032 (.813)	.205 (6.35)	1.310 (33.27)
RLV31	.01 (5)	.925 (23.50)	1.500 (38.1)	.040 (1.02)	.330 (8.38)	1.675 (42.55)
RLV32	.03 (13.6)	1.780 (42.21)	1.500 (38.1)	.040 (1.02)	.375 (9.53)	2.578 (65.48)

FIGURE 104-3. Registor style - Continued



Style	Maximum weight pounds (grams)	Dimensions					
		A ±.062 (±1.57)	B Min.	C ±.002 (±.050)	D ±.031 (±.787)	E ±.031 (±.787)	M ±.031 (±.787)
RLV40	.01 (5)	.875 (22.23)	1.00 (25.4)	.036 (.914)	.312 (7.92)	.312 (7.92)	1.625 (41.28)
RLV41	.012 (5.4)	.875 (22.23)	1.00 (25.4)	.036 (.914)	.343 (8.71)	.375 (9.53)	1.625 (41.28)
RLV42	.017 (7.7)	1.390 (35.31)	1.00 25.4)	.036 (.914)	.343 (8.71)	.375 (9.53)	2.140 (54.36)
RLV43	.028 (12.7)	1.875 (47.63)	1.00 (25.4)	.036 (.914)	.343 (8.71)	.375 (.953)	2.625 (66.68)

FIGURE 104-3. Registor style - continued.

Table 104-II Features	RLV10	RLV20	RLV21	RLV22	RLV23	RLV30
Max resistance-temperature characteristic ppm/°C-ppm						
.01 to .0249 ohm	±150	±100	±100	±225	±300	±350
.025 to .0499 ohm	±125	±100	±100	±225	±300	±200
.05 to .0749 ohm	±100	±100	±100	±250	±250	±125
.075 to .099 ohm	±50	±100	±100	±200	±250	±75
.01 ohm and above	±50	±100	±100	±175	±200	±50
Rated wattage at +25°C (watts)	5.0	3.0	5.0	7.0	10.0	3.0
Minimum resistance (ohms)	0.01	0.01	0.01	0.01	0.01	0.01
Maximum resistance (ohms)	0.50	0.10	0.10	0.10	0.10	0.20
Maximum overload current (amperes)	40.0	32.0	32.0	32.0	32.0	25.0
Available characteristics	T	L	L	L	L	T

Features	RLV31	RLV32	RLV40	RLV41	RLV42	RLV43
Max resistance-temperature characteristic ppm/°C-ppm						
.01 to .0249 ohm	±250	±350	±200	±200	±300	±400
.025 to .0499 ohm	±150	±200	±200	±200	±300	±400
.05 to .0749 ohm	±100	±150	±150	±150	±200	±350
.075 to .099 ohm	±75	±75	±150	±150	±200	±300
.01 ohm and above	±50	±75	±100	±100	±100	±100
Rated wattage at +25°C (watts)	5.0	10.0	3.0	5.0	7.0	10.0
Minimum resistance (ohms)	0.01	0.01	0.01	0.01	0.01	0.01
Maximum resistance (ohms)	0.30	0.80	0.10	0.10	0.10	0.10
Maximum overload current (amperes)	40.0	40.0	32.0	32.0	32.0	32.0
Available characteristics	T	L	L	L	L	L

Characteristics test or condition	Symbol T	Symbol L	Units
Maximum ambient temperature			
at rated wattage	25 watts	25 watts	°C
at zero power	275 watts	275 watts	°C
Thermal shock	±0.2%	±3.0%	Maximum percent change in resistance (0.0005 ohm additional allowed for measurement error)
Short time overload	±0.5%	±2.0%	
Terminal strength	±0.1%	±1.0%	
Dielectric withstanding voltage	±0.1%	±1.0%	
Insulation resistance ohms	1,000 M	1,000 M	
High temperature exposure	±1.0%	±1.0%	
Moisture exposure	±0.2%	±4.0%	
Low temperature storage	±0.2%	±2.0%	
Shock, specified pulse	±0.1%	±1.0%	
Vibration, high frequency	±0.1%	±2.0%	
Life	±1.0%	±4.0%	
Tolerance	1,3,5	5,10	± percent

TABLE 104-I. Standard resistance values.

F (1.0)	H (3.0) J (5.0)	K (10.0)	F (1.0)	H (3.0) J (5.0)	K (10.0)	F (1.0)	H (3.0) J (5.0)	K (10.0)	F (1.0)	H (3.0) J (5.0)	K (10.0)
0.0100	0.0100	0.0100	0.0182			0.0324				0.0560	0.0560
0.0102			0.0187				0.0330	0.0330	0.0562		
0.0105			0.0191			0.0332			0.0576		
0.0107			0.0196			0.0340			0.0590		
0.0110	0.0110		0.0200	0.0200		0.0348			0.0604		
0.0113			0.0205			0.0357			0.0619		
0.0115			0.0210				0.0360			0.0620	
0.0118			0.0215			0.0365			0.0634		
	0.0120	0.0120		0.0220	0.0220	0.0374			0.0649		
0.0121			0.0221			0.0383			0.0665		
0.0124			0.0226				0.0390	0.0390		0.0680	0.0680
0.0127			0.0232			0.0392			0.0681		
0.0130	0.0130		0.0237			0.0402			0.0698		
0.0133				0.0240		0.0412			0.0715		
0.0137			0.0243			0.0422			0.0732		
0.0140			0.0249				0.0430		0.0750	0.0750	
0.0143			0.0255			0.0432			0.0768		
0.0147			0.0261			0.0442			0.0787		
0.0150	0.0150	0.0150	0.0267			0.0453			0.0806		
0.0154				0.0270	0.0270	0.0464				0.0820	0.0820
0.0158			0.0274				0.0470	0.0470	0.0825		
	0.0160		0.0280			0.0475			0.0845		

TABLE 104-1. Standard resistance values - Continued.

F (1.0)	H (3.0) J (5.0)	K (10.0)	F (1.0)	H (3.0) J (5.0)	K (10.0)	F (1.0)	H (3.0) J (5.0)	K (10.0)	F (1.0)	H (3.0) J (5.0)	K (10.0)
0.0162			0.0287			0.0487			0.0866		
0.0165			0.0294			0.0499			0.0887		
0.0169				0.0300			0.0510		0.0909		
0.0174			0.0301			0.0511				0.0910	
0.0178			0.0309			0.0523			0.0931		
	0.0180	0.0180	0.0316			0.0536			0.0953		
						0.0549			0.0976		

SECTION 105

RESISTORS, FIXED, FILM, HIGH VOLTAGE, GENERAL SPECIFICATION FOR

STYLES RHV30, RHV31, RHV32, RHV33, RHV34, AND RHV35

(Applicable SPECIFICATION: MIL-R-49462)

1. SCOPE

1.1 Scope. This section covers the general requirements for, film, fixed, high voltage resistors primarily intended for incorporation into electronic circuits where high voltage and high resistance values are used.

2. APPLICATION INFORMATION

2.1 Construction. In these resistors the resistance element consists of a film element (with the exception of carbon films) protected against exposure to humidity by an enclosure or a coating of moisture resistant insulating material. Following spiraling 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-49462, processes and controls utilized in manufacturing are necessarily more stringent.

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 105-1.

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 two, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential.

2.4 Moisture resistance. Metal film resistors 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.

2.5 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 (RWMV). 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.

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

2.7 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.

2.8 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. 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.

2.9 Screening. All resistors furnished under MIL-R-49462 are subjected to conditioning through thermal shock and overload testing.

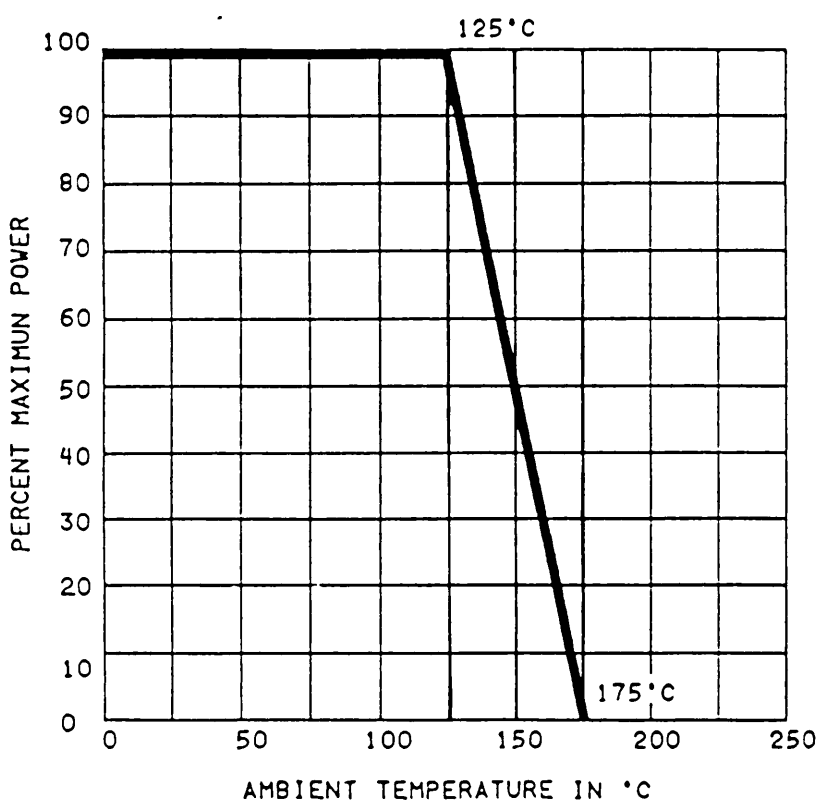


FIGURE 105-1. Derating curve figure 105-1.

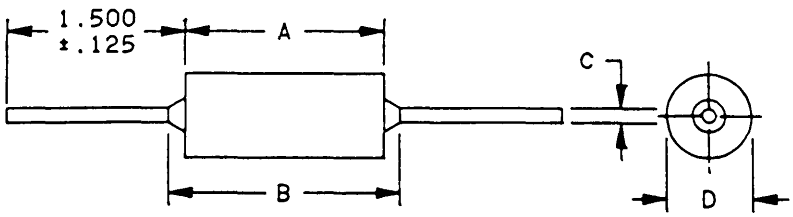
3. ITEM IDENTIFICATION (see figures 105-2 through 105-4).

3.1 Type designation. The type designation is used for identifying and describing the resistor as shown on figure 105-2 or figure 105-3.

3.2 Performance characteristics. The performance characteristics of these resistors are as shown in table 105-I.

3.3 Resistance values. Resistance values for the F (1.0 percent), G (2.0 percent), J (5 .0 percent), K (10.0 percent), and L (20.0 percent) tolerances shall follow the tabulation shown on page 105.4.

3.4 Physical construction. The physical construction of the resistors are as identified by style in folling diagrams.



Inches	mm
.032	0.81
.125	3.18
1.500	38.10

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

	RHV30	RHV31	RHV32	RHV33	RHV34	RHV35
A	0.275 ±0.031 (6.98 ±.079)	0.400 ±0.031 (10.16 ±0.79)	0.690 ±0.062 (17.53 ±1.57)	1.062 ±0.062 (26.97 ±1.57)	2.062 ±0.062 (52.37 ±1.57)	3.062 ±0.062 (77.77 ±1.57)
B max	0.400 (10.16)	0.525 (13.34)	0.900 (22.86)	1.250 (31.75)	2.250 (57.15)	3.250 (88.55)
C	0.25 ±.002 (.635 ±.05)	0.32 ±.002 (.81 ±.05)	0.32 ±.002 (.81 ±.05)	0.32 ±.002 (.81 ±.05)	.032 ±.002 (.081) .051	.032 ±.002 (.081) .051
D	0.088 ±0.010 (2.22 ±0.25)	0.138 ±0.016 (3.51 ±0.41)	0.297 ±0.031 (7.54 ±0.79)	0.297 ±0.031 (7.54 ±0.79)	0.297 ±0.031 (7.54 ±0.79)	0.297 ±0.031 (7.54 ±0.79)

Maximum voltages.

Resistor style	Voltage (volts maximum)	Style
RHV30	750	A
RHV31	1.5 k	B
RHV32	3.0 k	C
RHV33	5.0 k	D
RHV34	10.0 k	E
RHV35	20.0 k	F

FIGURE 105-11. Type designation.

M4946201 A A 100K F

Detail specification: This represents the military specification and slash sheet. (Shown is MIL-R-49462/01).

Characteristic: The single-letter symbol identifies the characteristic (as specified in table 105-1) as follows:

- A - - - <500 Mohm = 200 ppm, ≥ 500 Mohm = 500 ppm +70°C max ambient temperature at rated wattage
- B - - - <500 Mohm = 200 ppm, ≥ 500 Mohm = 500 ppm +125°C max ambient temperature at rated wattage
- C - - - <500 Mohm = 200 ppm. ≥ 500 Mohm = 500 ppm +125°C max ambient temperature at rated wattage

Style: The style shall be identified by a single letter; A, B, C, D, and E.

Resistance: The four-digit number identifies the nominal resistance value, expressed in ohms. The complete scheme is represented in table 105-11.

Example: See table 105-11.

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

- F - - - 1.0 percent (available in characteristic A)
- 2.0 percent (available in characteristic A)
- J - - - 5.0 percent (available in characteristic A)

FIGURE 105-2. Type designation example for styles RHV30 through RHV35.

TABLE 105-1. Performance characteristics.

Performance table	Characteristic A
Maximum resistance percent/°C temperature characteristic /ppm °C	< 500 M ohm = 200 ppm ≥ 500 M ohm = 200 ppm
Maximum ambient temperature at rated wattage	+70°C
Maximum ambient temperature at zero wattage derating	+175°C
Power rating in watts and maximum dc or rms voltage:	
RHV30	.25 W 750 V
RHV31	.5 W 1.5 kV
RHV32	1.0 W 3.0 kV
RHV33	2.0 W 5.0 kV
RHV34	3.0 W 10.0 kV
RHV35	5.0 W 20.0 kV
Maximum percent change in resistance ±	
Thermal shock	0.5
Dielectric withstanding voltage	0.25
Life	5.0
Shock	2.0
Terminal strength	0.2
Vibration, high frequency	2.0
Low temperature operation	2.0
Resistance tolerance ± percent	1(F), 2(G), 5(J)

SECTION 200

RESISTORS, VARIABLE

SECTION 201

RESISTORS, VARIABLE, COMPOSITION

STYLES RV2, RV4, RV6, 2RV7, AND RV8

(APPLICABLE SPECIFICATION: MIL-R-94)

1. SCOPE

1.1 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 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.

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

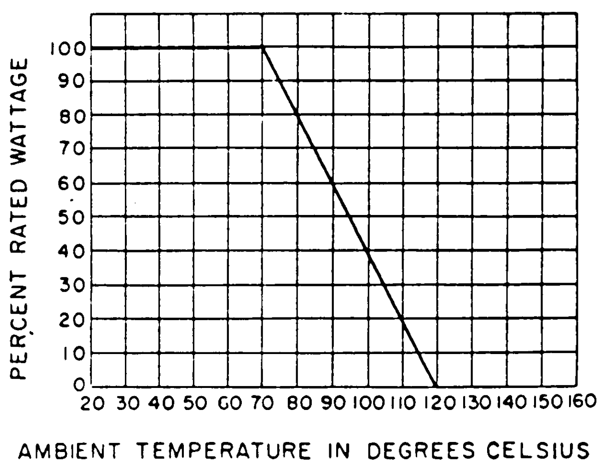


FIGURE 201-1. Derating for high ambient temperature.

2.1.4 Derating for optimum performance. After the anticipated 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 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 continues continuous working voltage (RCWV) are as follows:

Resistance value	RCWV (volts) 1/ Taper A	RCWV (volts) 1/ Taper C	Resistance value	RCWV (volts) 1/ Taper A	RCWV (volts) 1/ 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

See footnotes at end of list.

Resistance value	RCWV (volts) 1/		Resistance value	RCWV (volts) 1/	
	Taper A	Taper C		Taper A	Taper C
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			
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

Resistance value	RCWV (volts) 3/ — Resistance characteristic combination A: 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

See footnotes at end of list.

Style 2RV7		
RCWV (volts) 3/		
Resistance characteristic combination		
A		
Resistance value	Panel section	Rear section
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

Resistance value	RCWV (volts) 3/		Resistance value	RCWV (volts) 3/	
	Taper A	Tapers C and F		Taper A	Tapers C and F
Style RV8					
100Ω	7	5	.10 MΩ	224	160
200Ω	10	7	.20 MΩ	316	200
250Ω	11	8	.25 MΩ	350	200
500Ω	16	11	.50 MΩ	350	200
1,000Ω	22	16	1.0 MΩ	350	200
2,000Ω	31	22	2.0 MΩ	350	200
2,500Ω	35	25	2.5 MΩ	350	200
5,000Ω	50	36	5.0 MΩ	350	200
10,000Ω	71	50			
25,000Ω	112	80			
50,000Ω	158	112			

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)

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 - - - .625 inch, screwdriver slot (locking bushing type T)
- D - - - .875 inch, knob (standard bushing type S)
- B - - - .500 inch, screwdriver slot (standard bushing type S, RV4 only)
- L - - - .375 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.

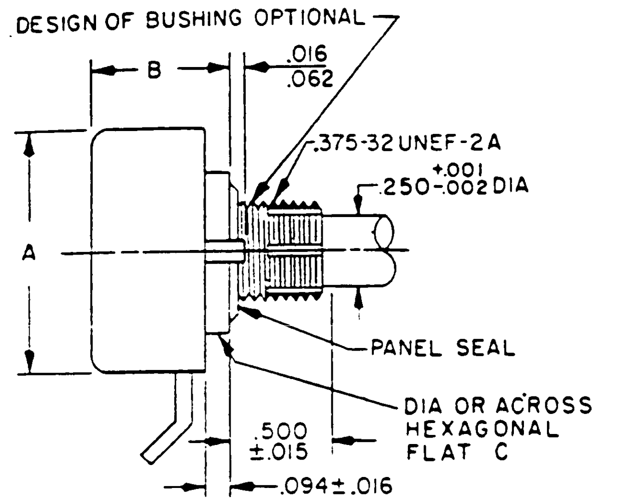
Operating shaft: The operating shaft styles and lengths are identified by a two-letter symbol. The first letter indicates operating shaft style in accordance with MIL-R-94, and the second letter indicates operating shaft length as specified in table 201.1.

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 identied 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.

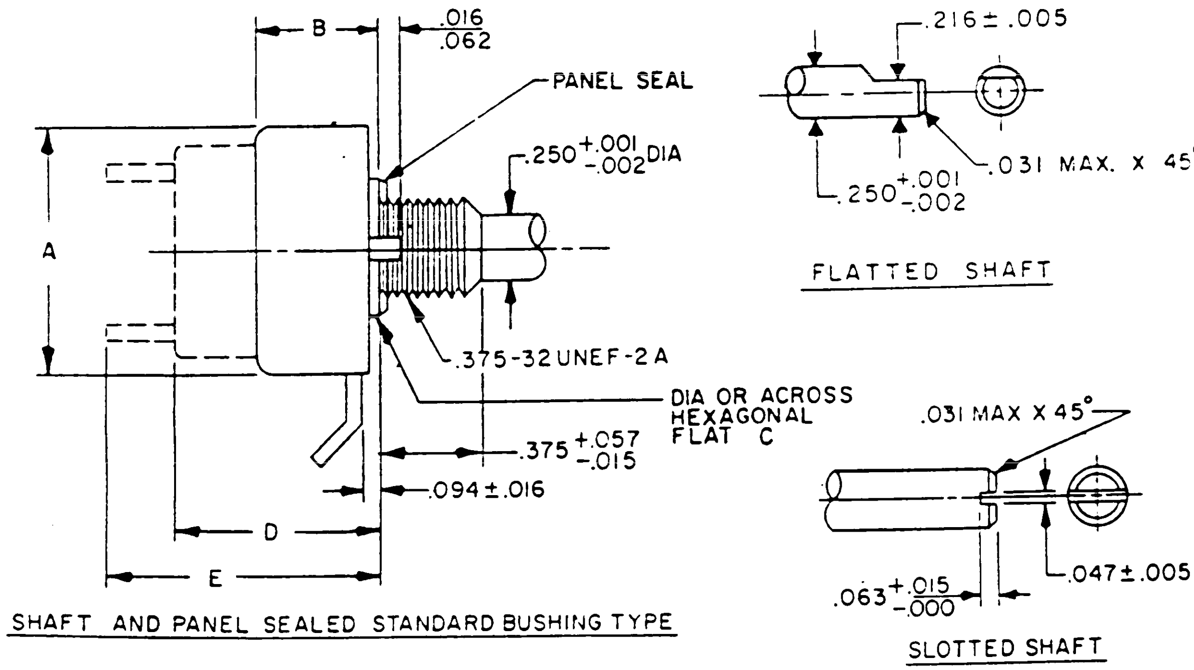


SHAFT AND PANEL SEALED LOCKING BUSHING TYPE

Style	A	B	C	D	E
RV2	.906 (23.01)	.500 ±.019 (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)

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

FIGURE 201-4. Composition, variable resistors.



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.062 (1.57 mm).

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

STYLE 2RV7

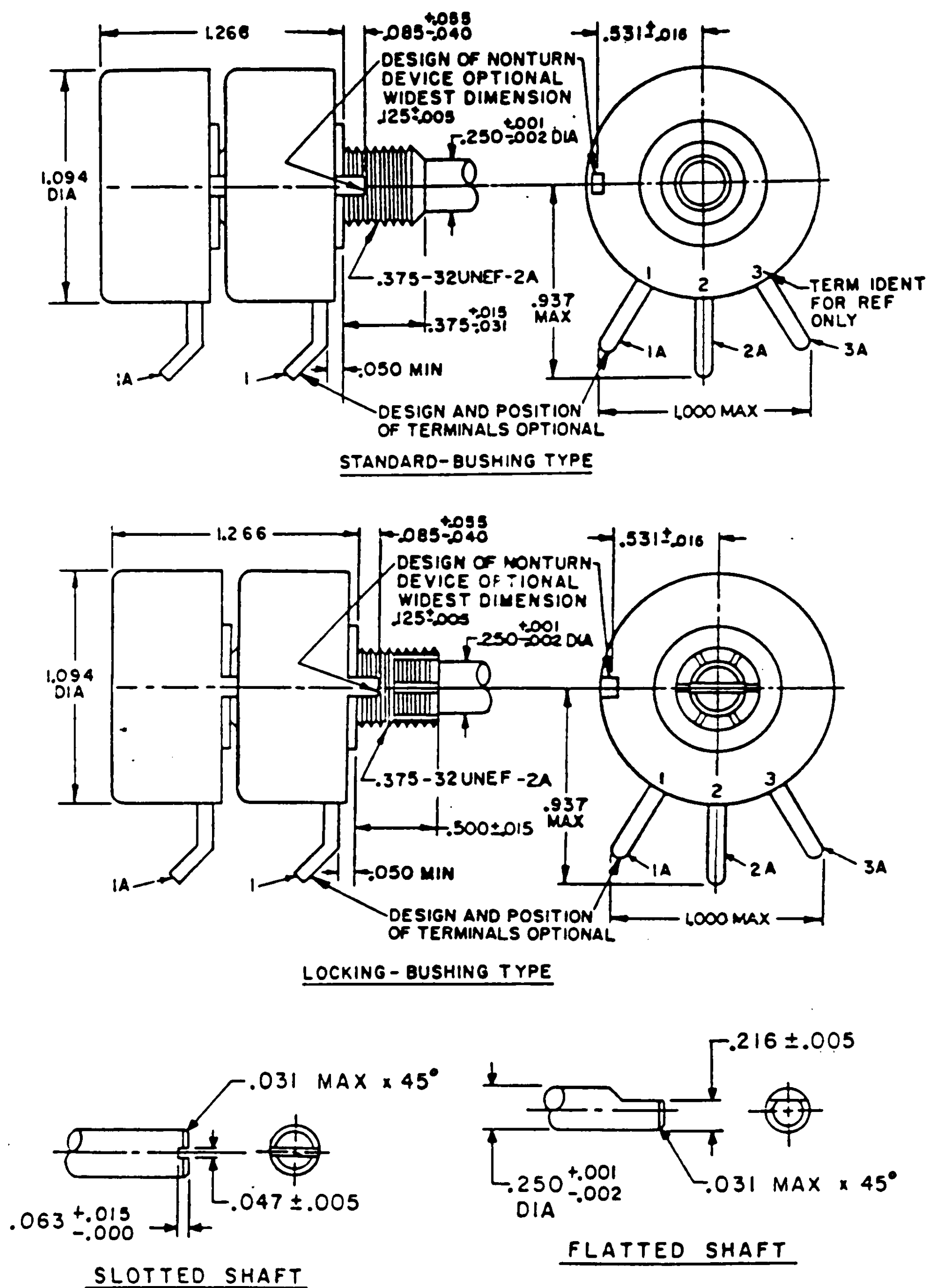
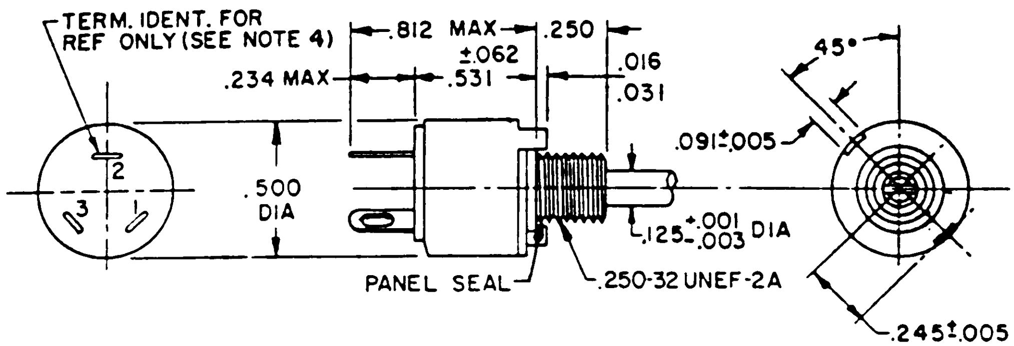
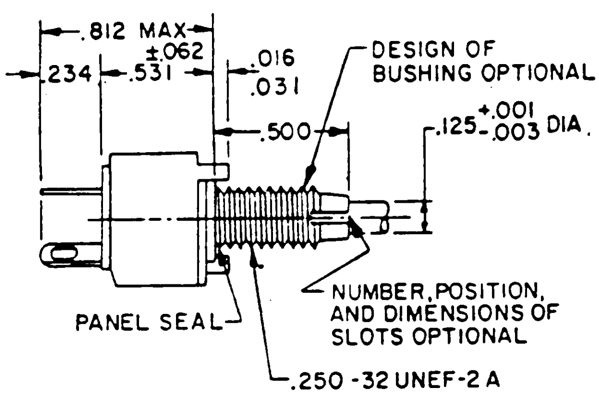


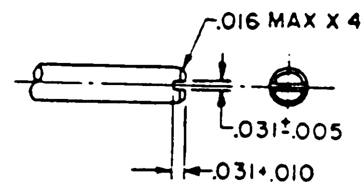
FIGURE 201-4. Composition, variable resistors - Continued.

STYLE RV6



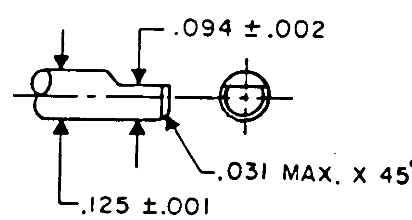
SHAFT AND PANEL SEALED STANDARD BUSHING TYPE





SLOTTED SHAFT

SHAFT AND PANEL SEALED LOCKING BUSHING TYPE

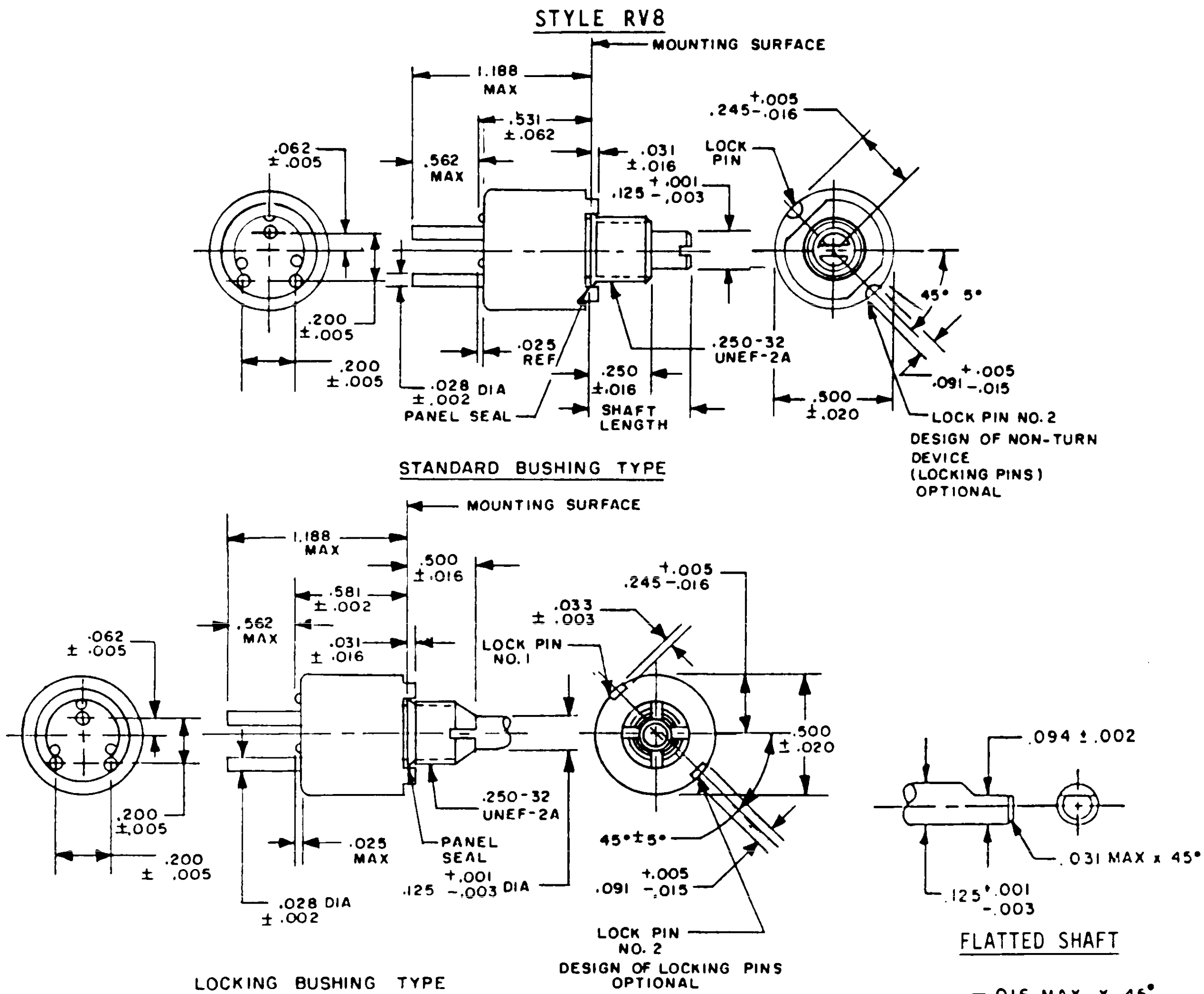


FLATTED SHAFT

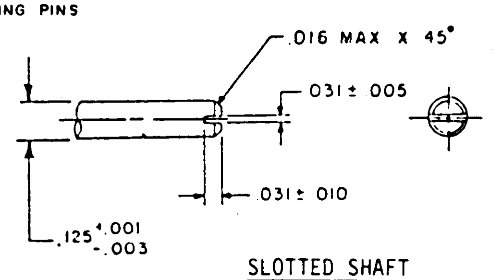
Inches	mm	Inches	mm	Inches	mm
.001	0.03	.031	0.79	.245	6.22
.002	0.05	.062	1.57	.250	6.35
.003	0.08	.091	2.31	.500	12.70
.005	0.13	.094	2.39	.531	13.49
.010	0.25	.125	3.18	.812	20.62
.016	0.41	.234	5.94		

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is l .016 (0.41 mm).
4. 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.



Inches	mm	Inches	mm	Inches	mm
.001	0.03	.031	0.79	.250	6.35
.002	0.05	.033	0.84	.453	11.51
.003	0.08	.062	1.57	.500	12.70
.005	0.13	.091	2.31	.531	13.49
.010	0.25	.094	2.39	.562	14.29
.015	0.38	.125	3.18	.581	14.76
.020	0.51	.200	5.08	.688	17.48
.025	0.64	.234	5.94	.812	20.62
.028	0.71	.245	6.22	1.88	47.8



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is 1.016 (0.41 mm).
4. When terminals are located symmetrically, the contact terminal shall be identified on the unit. The-identifying mark shall be 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.)

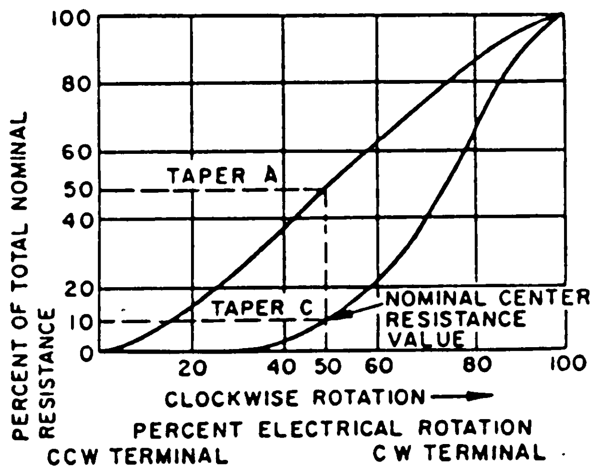


FIGURE 201-5. Clockwise taper.

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 201-1. Performance characteristics.

Features	Style				
	RV2	RV4	RV6	2RV7	RV8
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	Same as RV4
Switch	None	None	None	None	None
Style shaft Length	Slotted .625 inch (T bushing); .500 and .875 inch (S bushing)	Slotted .625 inch (T bushing); .500 and .875 inch (S bushing)	Slotted .625 inch (T bushing); .375 and .875 inch (S bushing)	Slotted .625 inch (T bushing); .500 and .875 inch (S bushing)	Slotted .625 inch (T bushing); .500 and .875 inch (S bushing)
Style shaft Length	Flatted .875 inch (S bushing)	Flatted .875 inch (S bushing)	Flatted .875 inch (S bushing)	Flatted .875 inch (S bushing)	Flatted .875 inch (S bushing)
Minimum resistance, ohms:					
Taper A (linear)	100	50	100	50	100
Taper C (10 percent CW)	100	100	100	50	100
Maximum resistance, megohms:					
Taper A (linear)	2.5	5	5	5	5
Taper C (10 percent CW)	2.5	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	Same as RV4
Power rating, watts (at +70°C):					
Taper A (linear)	1	2	.500	0-2 (panel), 1.6-0 (rear) taper A only	.500 (taper A)
Taper C (10 percent CW)	.500	1	.250		.250 (taper C)
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	1 inch-ounce min; 12 inch-ounces max	.5 inch-ounce min; 6 inch-ounces max
Stopping	8 inch-pounds	8 inch-pounds	3 inch-pounds	Same as RV4	Same as RV4
Total mechanical rotation, degrees:					
Without switch	251 to 318	309 to 320	292 to 298	309 to 320	292 to 298
Electrical rotation, degrees:					
Without switch	251 to 318	309 to 320	292 to 298	309 to 320	292 to 298
Resistant to moisture	Yes	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	Same as RV4 Same as RV4
Max percent change in resistance (*):					
Load life (1,000 hr)	10 percent	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	3 percent
Low temperature storage	2 percent	2 percent	2 percent	2 percent	2 percent
Vibration (low frequency)	2 percent	2 percent	2 percent	2 percent	2 percent
Shock	2 percent	2 percent	2 percent	2 percent	2 percent
Vibration (high frequency)	2 percent	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	Same as RV4
Effect of soldering Dielectric strength	No mechanical or electrical damage	No mechanical or electrical damage	Same as RV4	Same as RV4	Same as RV4
Salt spray	Mechanically operative	Mechanically operative	Same as RV4	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

1.1 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 202-1. Maximum permissible current.

Taper	Maximum permissible current	
	High-resistance section	Low-resistance section
Linear (A)	W/R	---
Taper (C)	0.745 W/R	2.24 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.

resistance

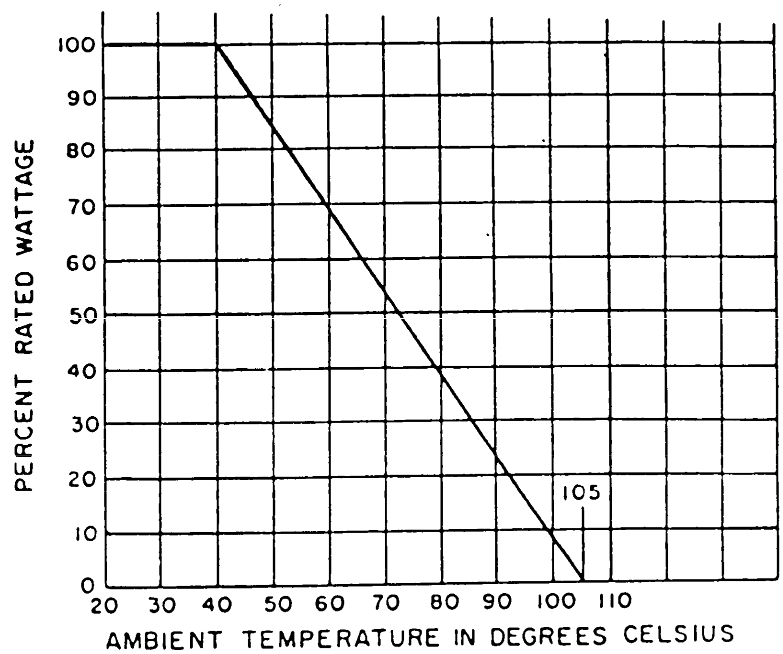


FIGURE 202-1. Derating curve for continuous duty.

2.1.5 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of two 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 202-11 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 - - - .625 inch, screwdriver slotted (locking bushing type T)
D - - - .875 inch, knob (standard bushing type S)
A - - - .500 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

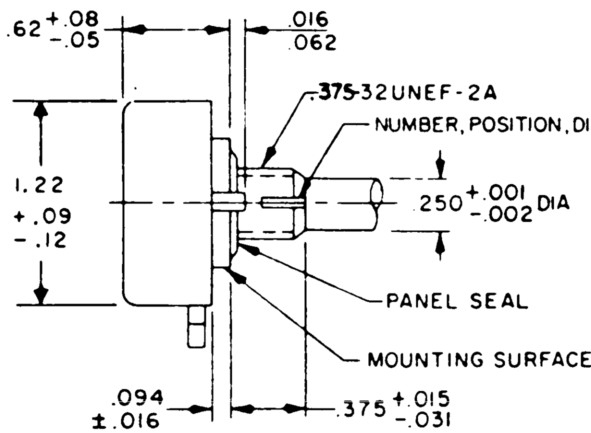
3R0 - - - -	3.0 ohms
100 - - - -	10 ohms
101 - - - -	100 ohms

Resistance characteristic: The single-letter symbol normal resistance characteristic as follows:

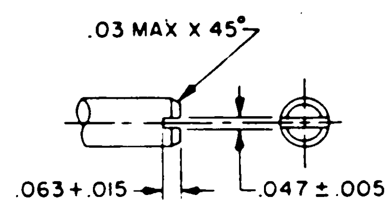
A - - - Taper A (linear CW), ±10 percent resistance tolerance
C - - - Taper C (LO percent CW) ±10 percent resistance tolerance

FIGURE 202-2. Type designation example.

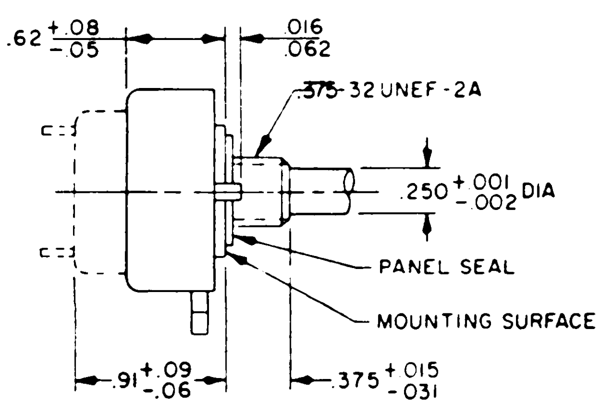
STYLE RA20



SHAFT AND PANEL SEALED LOCKING BUSHING TYPE



SLOTTED SHAFT

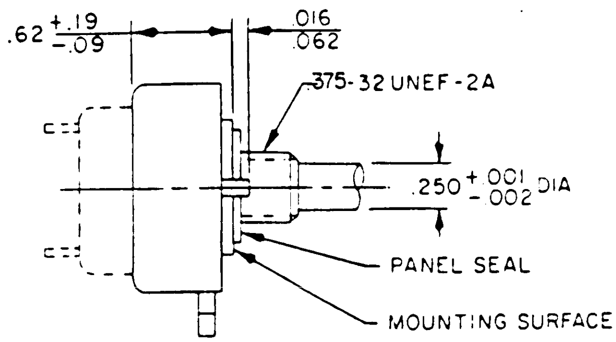


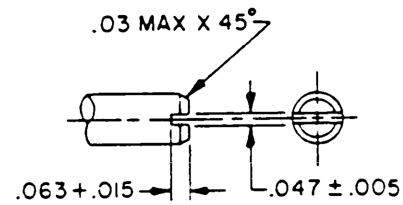
SHAFT AND PANEL SEAL TYPE, STANDARD BUSHING

Inches	mm	Inches	mm
. 001	0.03	.063	1.60
.002	0.05	.08	2.0
.005	0.13	.09	2.3
.015	0.38	.094	2.39
.016	0.41	.12	3.1
.031	0.79	.250	6.35
.047	1.19	.375	9.52
.05	1.27	.62	15.8
.06	1.52	.91	23.1
.062	1.57	1.22	3104

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

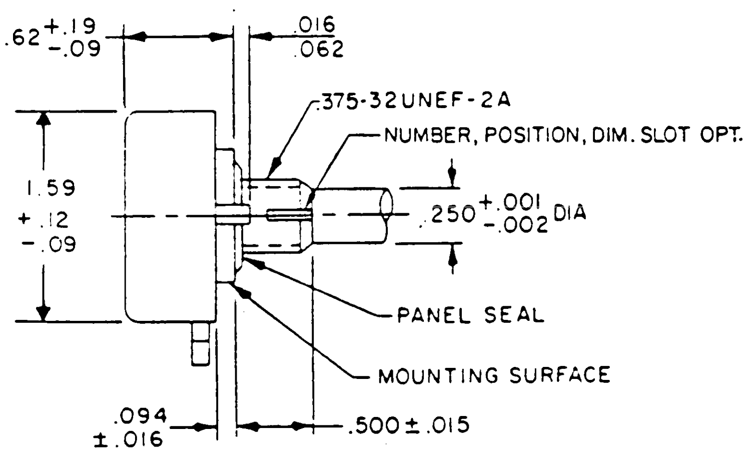
STYLE RA30





SLOTTED SHAFT

SHAFT AND PANEL SEAL TYPE STANDARD BUSHING



SHAFT AND PANEL SEALED LOCKING BUSHING TYPE

Inches	mm	Inches	mm
.001	0.03	.062	1.57
.002	0.05	.063	1.60
.005	0.13	.08	2.0
.015	0.38	.09	2.3
.016	0.41	.094	2.39
.03	0.8	.12	3.1
.031	0.79	.250	6.35
.047	1.19	.375	9.53
.05	1.3	.62	15.8
.06	1.5	.91	23.1
		1.59	40.4

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.)

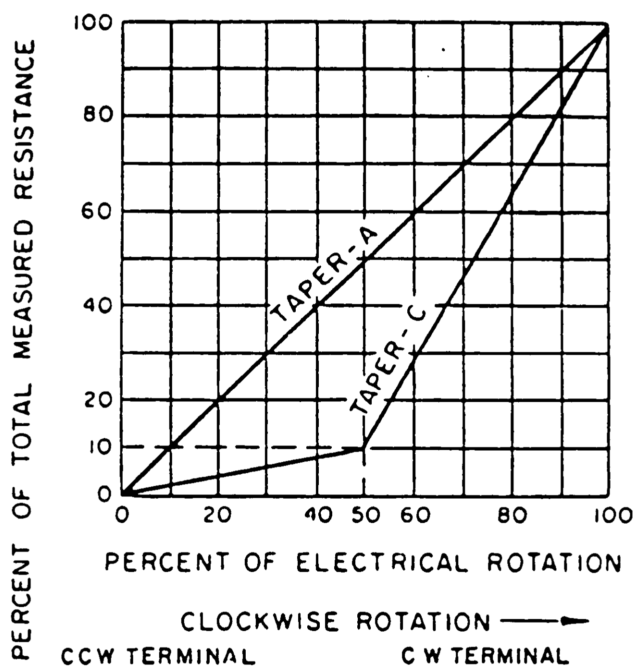


FIGURE 202-4. Clockwise tapers.

TABLE 202-11. 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	.625 (locking bushing) .500 and .875 (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

1.1 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).

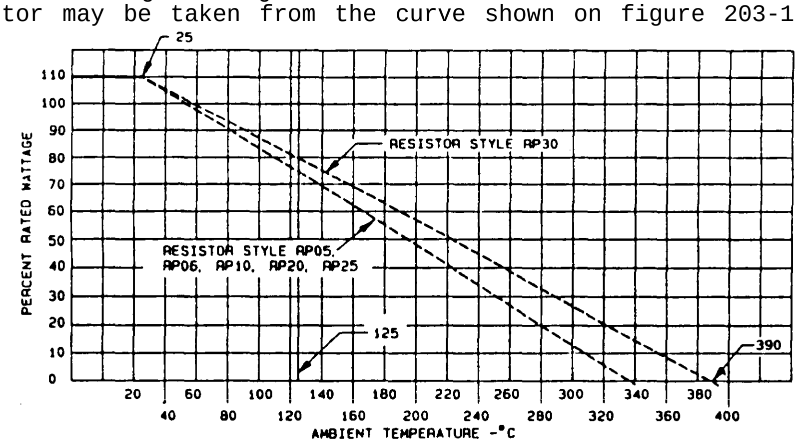
2. APPLICATION INFORMATION

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 two 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
U = 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 PIN. The PIN is used for identifying the resistor as shown on figure 203-2.

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

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in table 263-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 203-1 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 on 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 lenght of the operating shaft (.046 inch) as follows:

A - - - .500 inch, standard bushing (RP10, RP15, RP20, RP25, and RP30)
B - - - .625 inch. standard bushing (RP05 and RP06); and locking bushing (RP05, RP06, RP10, RP15, RP20, RP25, and RP30)
D - - - .875 inch, locking. bushing (RP05); and standard bushing (RP10, RP15, RP20, RP25, and RP30)
J - - - 2.000 inch, standard bushing (RP06, RP10, RP15, RP20, RP25, and RP30)
S - - - .375 inch, standard bushing (RP06)

FIGURE 203-2. PIN 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 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 - - - .500 inch, standard bushing (RP10, RP15, RP20, RP25, and RP30)
B - - - .625 inch, standard bushing (RP05 and RP06); and locking bushing (RP05, RP06 RP10, RP15, RP20, RP25, and RP30)
D - - - .875 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 - - - .375 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):

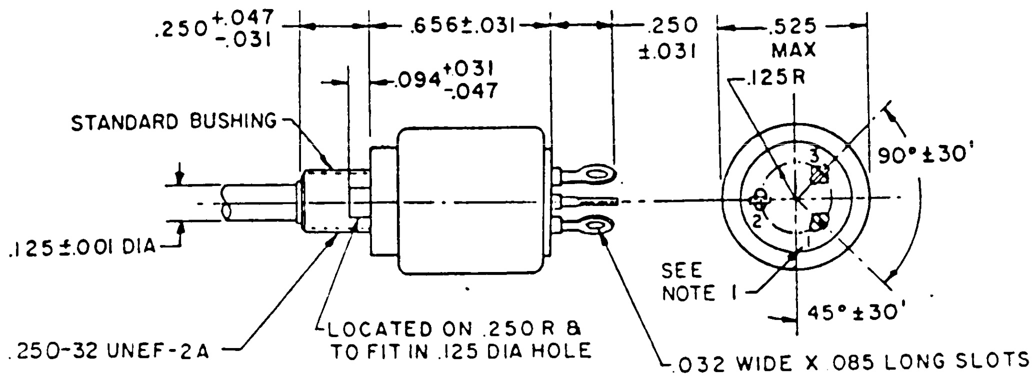
Example:

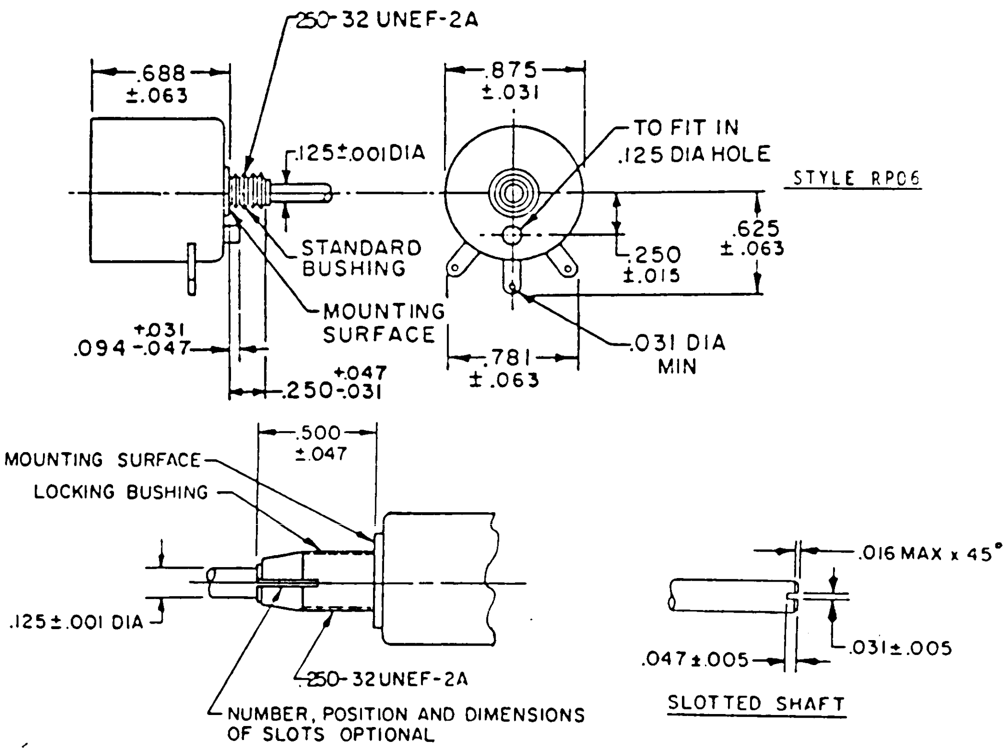
1R0 - - - - 1.0 ohm
100 - - - - 10 ohms
101 - - - - 100 ohms

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

FIGURE 203-3. Type designation example.

STYLE RP05





Inches	mm
.001	0.03
.005	0.13
.015	0.38
.016	0.41
.031	0.79
.032	0.81
.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 .250-32 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 (0.33 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 .250-32 UNEF-2B.

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

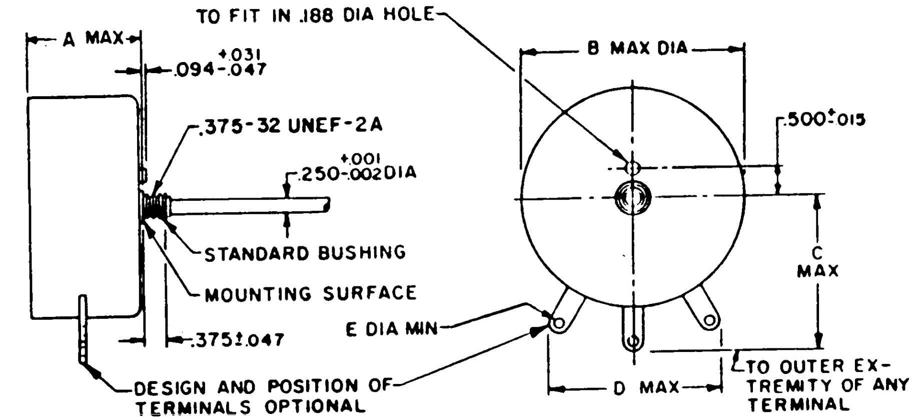
Style RP05			
PIN (see note 1)	Nominal total resistance value (ohms)	Maximum current (amperes)	Type designation (for reference only) (see note 1)
M22/15-0001---	10	.707	RP05---100KK
M22/15-0002---	15	.583	RP05---150KK
M22/15-0003---	25	.447	RP05---250KK
M22/15-0004---	35	.374	RP05---350KK
M22/15-0005---	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 (see note 2)	.056	RP05---152KK
M22/15-0016---	2,500 (see note 2)	.045	RP05---252KK
M22/15-0017---	3,500 (see note 2)	.037	RP05---352KK
M22/15-0018---	5,000 (see note 2)	.032	RP05---502KK

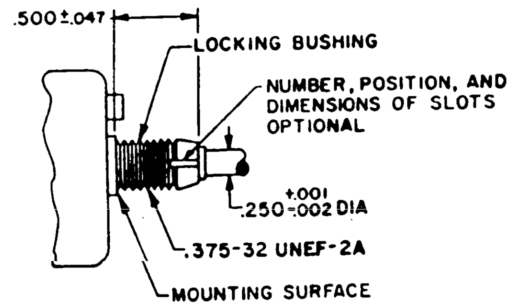
Style RP06			
PIN (see note 1)	Nominal total resistance value (ohms)	Maximum current (amperes)	Type designation (for reference only) (see note 1)
M22/01-0001---	1.0	3.53	RP06---1R0KK
M22/01-0002---	2.0	2.50	RP06---2R0KK
M22/01-0003---	2.5	2.23	RP06---2R5KK
M22/01-0004---	3.0	2.04	RP06---3R0KK
M22/01-0005---	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

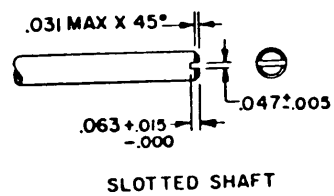
NOTES:
1. The complete PIN (and type designation) includes symbols indicating electrical off position, style of shaft and type of mounting, and length of operating shaft (see figure 203-2 for PIN and 203-3 for type designation).
2. Values based on use of wire size smaller than .0025 inch but not less than .0014 inch.

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

STYLES RP10, RP15, AND RP20







Standard style	Dimensions (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	see note 1
RP25	1.780	3.190	2.190	2.690	see note 1
RP30	2.030	4.060	2.440	3.000	see note 1

Inches	mm	Inches	mm
.001	0.03	1.440	36.58
.002	0.05	1.680	42.67
.005	0.13	1.780	45.21
.015	0.38	1.820	46.23
.031	0.79	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

NOTES:

1. To clear number 8 screw.
2. These-styles are supplied with one .375-32 UNEF-2B corrosion-resistant, hexagonal mounting nut having a nominal thickness of .094 (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 (3.84 mm) to .234 inch (5.94 mm) thick, .500 inch (12.70 mm) across the hexagonal flats; thread size is .375-32 UNEF-2B.

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

STYLES RP10, RP15, AND RP20

PIN (see note)			Nominal total resist-ance value (ohms)	Maximum current (amperes)			Type designation (see note)		
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---
---	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
0025---	0028---	0027---	8,000	---	0.08	0.10	---	802KK	802KK
---	0029---	0028---	10,000	---	0.07	0.09	---	103KK	103KK

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

STYLES RP25 AND RP30

PIN (see note)		Nominal total	Maximum current (amperes)		Type designation (see note)	
Style RP25	Style RP30	resistance value (ohms)	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

NOTE: The complete PIN (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 PIN and 203-3 for type designation).

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

TABLE 203-I. Performance characteristics.

Features	Style						
	RP05	RP06	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 $\leq$8 inch-ounces	Torque $\leq$8 inch-ounces	Torque $\leq$4 inch-pounds	Torque $\leq$4 inch-pounds	Torque $\leq$4 inch-pounds	Torque $\leq$4 inch-pounds	Torque $\leq$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	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Locking bushing 500 cycles							
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, RR1OOO, RR11OO, RR1300, RR1400, RR2000, RR21OO, RR3000, RR31OO, RR3200, RR3300, RR3400, RR3500, RR3700, RR3900, RR4000, AND RR41OO

(Applicable SPECIFICATION: MIL-R-12934)

1. SCOPE

1.1 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 risistors 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 normal wattage at an ambient temperature of +85°C. When a resistor is to be used where the surrounding tempature 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.

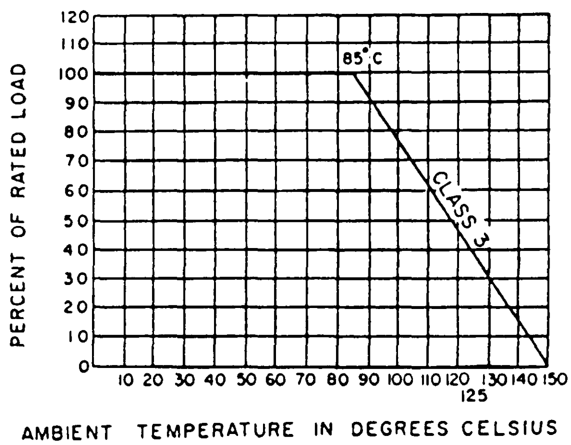


FIGURE 204-1. Derating curves for high ambient temperatures.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of two 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 204-1 and 204-11.

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 204-1 and 204-11.

RR0900 B 3 A 9 G 101

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 FCI and RT as follows:

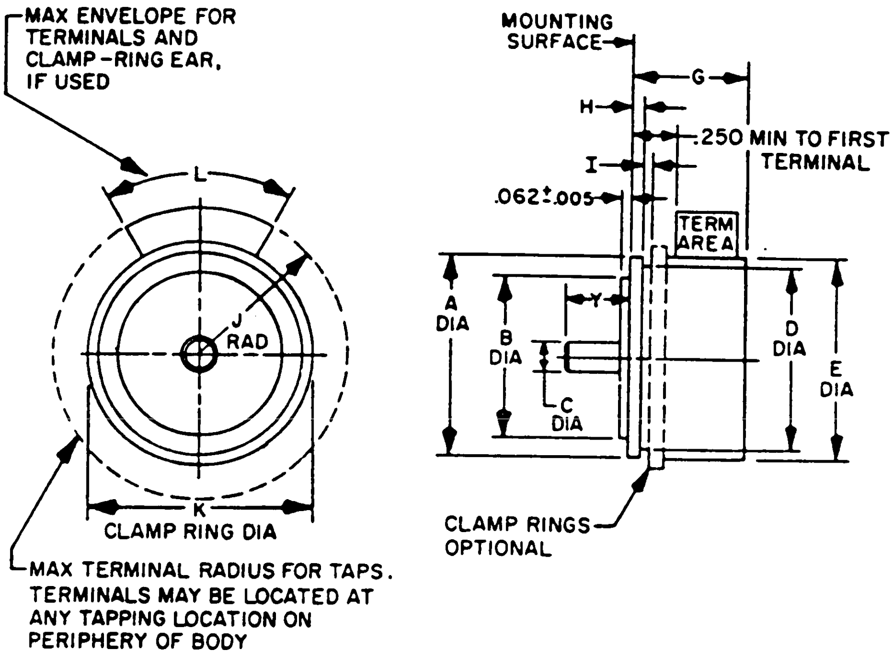
G - - - - - ±1.0 percent FCT; ±3 percent RT
J - - - - - ±0.10 percent FCT; ±3 percent RT
L - - - - - ±0.025 percent FCT; ±3 percent RT
S - - - - - ±1.0 percent FCT; ±1 percent RT
V - - - - - ±0.10 percent FCT; ±1 percent RT
Y - - - - - ±0.025 percent FCT; ±1 percent RT

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 - Continued.

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



Style	Dimensions									
	A +.005(.13) -.010(.25)	B -.0005 (0.01)	C -.0005 (0.01)	D Max	E Max	G Max	H ±.005 (0.13)	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

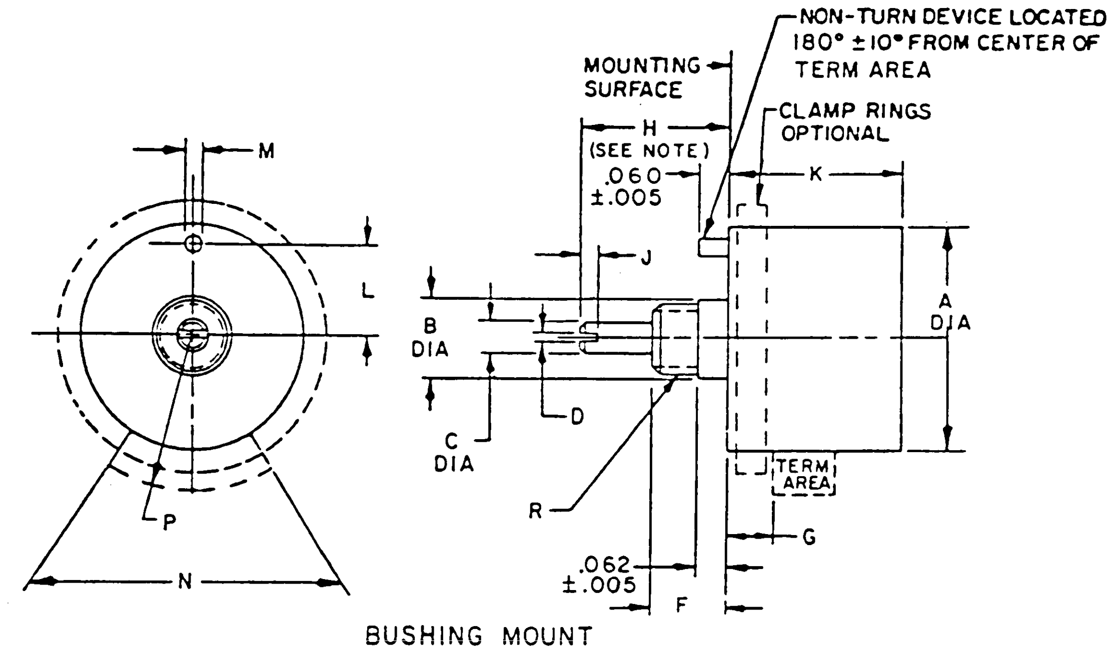


FIGURE 204-3. Wirewound, precision variable resistors - Continued.

Style	Dimensions						
	A max	B ±.010 (0.25)	C ±.005 (0.13)	D ±.010 (0.25)	F ±.020 (0.51)	G min	J ±.010 (0.25)
RR3100	.906 (23.01)	.281 (7.14)	.125 (3.18)	.040 (1.02)	.250 (6.35)	.080 (2.03)	.040 (1.02)
RR3200	1.093 (27.76)	.281 (7.14)	.125 (3.18)	"	.250 (6.35)	.100 (2.54)	.040 (1.02)
RR3300	1.468 (37.29)	.406 (10.31)	.250 (6.35)	"	.375 (9.52)	"	.060 (1.52)
RR3400	2.031 (51.59)	.406 (10.31)	.250 (6.35)	"	.375 (9.52)	"	.060 (1.52)
RR3500	3.031 (76.99)	.406 (10.31)	.250 (6.35)	.050 (1.27)	.375 (9.52)	"	.060 (1.52)
RR3700	.906 (23.01)	.281 (7.14)	.125 (3.18)	.040 (1.02)	.250 (6.35)	.080 (2.03)	.040 (1.02)
RR3900	.906 (23.01)	.281 (7.14)	.125 (3.18)	"	.250 (6.35)	"	"
RR4000	.875 (22.22)	.281 (7.14)	.125 (3.18)	"	.313 (7.95)	"	"
RR4100	1.844 (46.84)	.406 (10.31)	.250 (6.35) ±.002 (0.05)	"	.313 (7.95)	"	"

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

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

Style	Dimensions					
	K max	L ±.005 (0.13)	M ±.005 (0.13)	N max	P max	R Threads (UNEF-2A)
RR3100	.750 (19.05)	.312 (7.92)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR3200	.750 (19.05)	.312 (7.92)	.062 (1.57)	105°	.781 (19.84)	.250-32
RR3300	1.062 (26.97)	.531 (13.49)	.125 (3.18)	100°	1.094 (27.79)	.375-32
RR3400	1.156 (29.36)	.750 (19.05)	.125 (3.18)	90°	1.375 (34.93)	.375-32
RR3500	1.156 (29.36)	1.000 (25.40)	.125 (3.18)	90°	1.750 (44.45)	.375-32
RR3700	1.076 (27.33)	.312 (7.92)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR3900	1.219 (30.96)	.312 (7.92)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR4000	1.500 (38.10)	.302 (7.66)	.062 (1.57)	105°	.625 (15.88)	.250-32
RR4100	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 204-1. Performance characteristics.

Features	Style							
	RR0900	RR1100	RR2000	RR3000	RR1000	RR1300	RR1400	RR2100
Shaft - diameter	.125	.125	.250	.250	.125	.250	.250	.250
Cup - diameter	.875	1.062	2	3	.875	1.437	1.437	2
Resistance range								
Maximum	10 kΩ	20 kΩ	60 kΩ	100 kΩ	50 kΩ	40 kΩ	200 kΩ	250 kΩ
Minimum	100 kΩ	100 kΩ	100 kΩ	200 kΩ	100 kΩ	100 kΩ	200 kΩ	200 kΩ
Power rating, watts at								
+85°C	1.25	1.5	4	6	2	2	3	5
+150°C	0	0	0	0	0	0	0	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	.30	.50	1.0	1.5	.7	1.0	1.0	2.0
Running	.25	.30	1.0	1.0	.6	.75	.7	1.0
Travel (degrees)								
Electrical	350	350	350	350	3,600	350	3,600	3,600
Mechanical	360	360	360	360	3,600	360	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 204-11. 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	10 kΩ	20 kΩ	40 kΩ	60 kΩ	100 kΩ	50 kΩ	100 kΩ	50 kΩ	250 kΩ
Minimum	100 kΩ	100 kΩ	100 kΩ	100 kΩ	200 kΩ	100 kΩ	100 kΩ	200 kΩ	200 kΩ
Power rating, watts at									
+85°C	1.25	1.50	2	4	6	1.50	1.50	2	5
+150°C	0	0	0	0	0	0	0	0	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	.30	.50	1.0	1.0	1.5				
Running	.25	.40	.75	1.0	1.0				
Travel (degrees)									
Electrical	350	350	350	350	350	1,080	1,180	3,600	3,600
Mechanical	360	360	360	360	360	1,080	1,180	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

1.1 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.

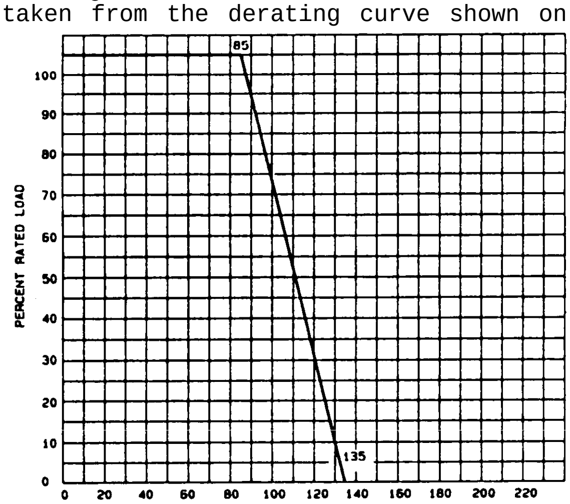


FIGURE 205-1. Derating curve for high ambient temperature.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of two 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 PIN. The PIN 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 on figure 205-4 and corresponds to the type designation per figure 205-3.

FIGURE 205-2. PIN 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 265-1.

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 of 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

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.

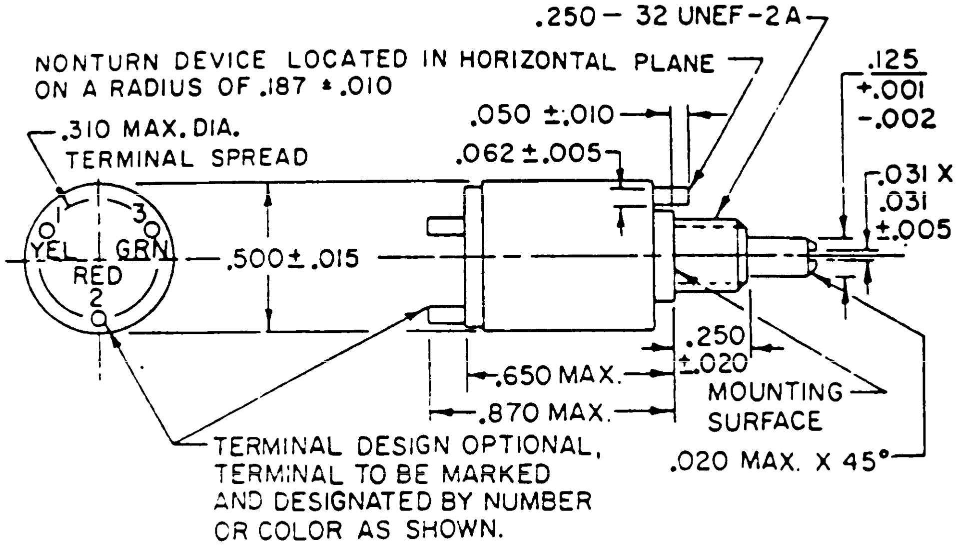
Resistance: The three-digit number identifies the nominal total resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. (See 3.4 and the following example.)

Example:

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

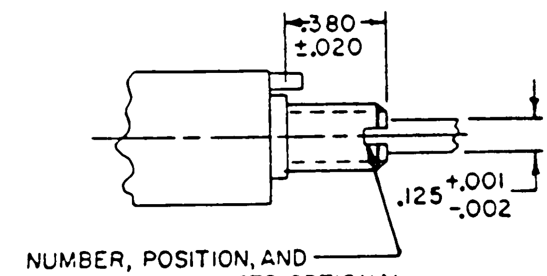
FIGURE 205-3. Type designation example.

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 (1.57 mm) thick which measures .312 (7.92 mm) across the hexagonal flats. For locking bushings, the locking nut is .125 (3.18 mm) thick and measures .312 (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 (1.14 mm). Retainer rings, if used, are not thicker than .032 (0.81 mm).

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

Nominal total resistance (ohms)	PIN M39002/01-				Type designation (see note)
	.500 inch slotted shaft		.625 inch slotted shaft		
	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

NOTE: 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 205-1. Performance requirements.

Features	Style RK09
Max resistance-temperature characteristic in ppm/°C (Ref to +25°C) — 50 ohms and over	±70
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)	500Ω
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, RT10

(Applicable SPECIFICATION: MIL-R-27208)

1. SCOPE

1.1 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 .062-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.

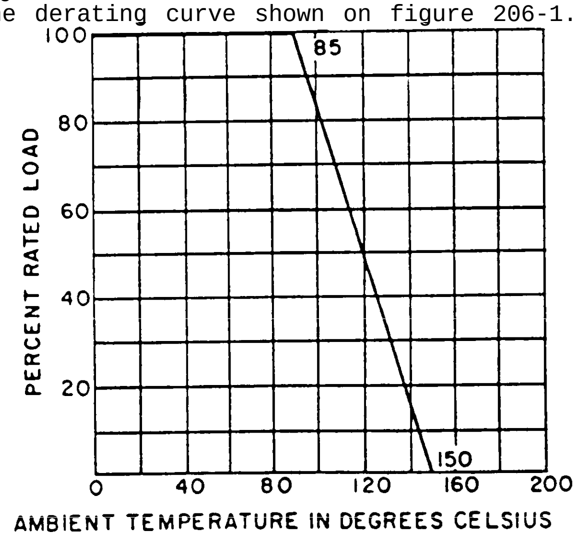


FIGURE 206-1. Derating curve for high-ambient temperature.

2.1.4 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of two 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 nonwirewound 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 266-I.

3.3 Preferred nominal resistance value, maximum resolution, and rated working voltage. The preferred normal 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 *	0.44	20.00

* 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; — RT26

Resistance-temperature characteristic: The single-letter symbol identifies the resistance-temperature characteristic as follows: — C

C - - - - - - - - 50 ppm/°C (ref to ±25°C

Temperature characteristic: The single-digit number identifies the temperature characteristic as follows: — 2

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

Terminals: The single-letter symbol identifies the terminals as follows: — W

P - - - - - Printed circuit pins
w - - - - - Printed-circuit pins (edge-mounted)
x - - - - - Printed-circuit pins (edge-mounted, alternate configuration)

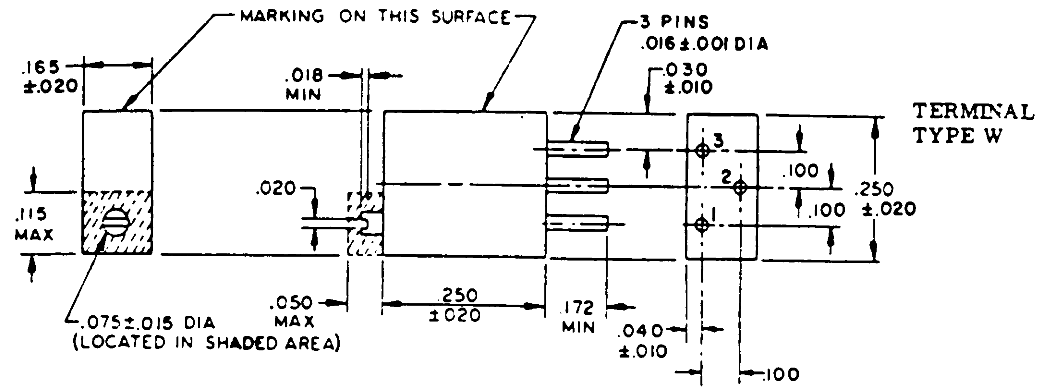
Resistance: The three-digit number identifies the nominal resistance value, expressed in ohms; the first two digits represent significant figures and the last digit specifies the number Of zeros to follow (See 3.3 and the following example.) — 102

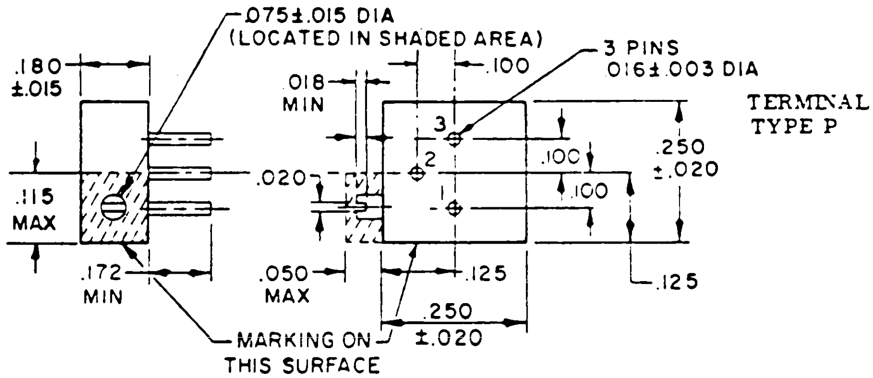
Example:

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

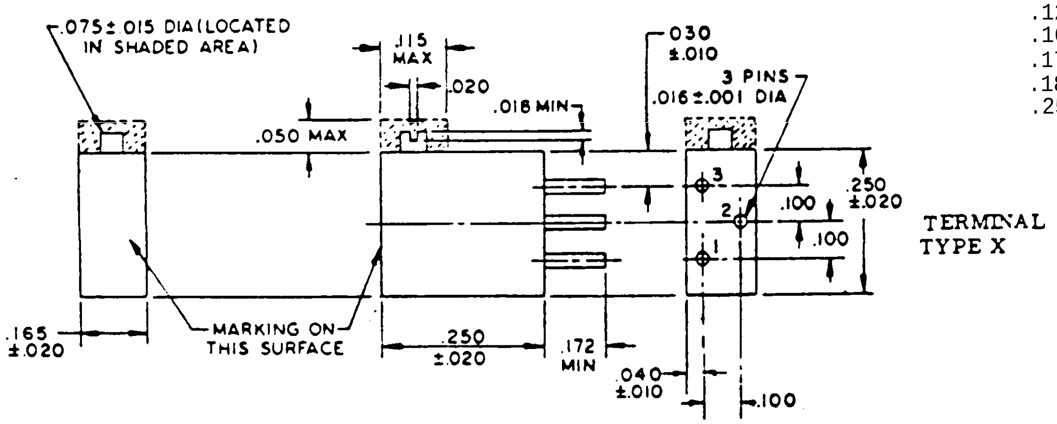
FIGURE 206-2. Type designation example.

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	0.03
.003	0.08
.010	0.25
.015	0.38
.016	0.41
.018	0.46
,020	0.51
. 030	0.76
.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. 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 is above the surface of the unit.

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

TABLE 206-1. Performance characteristics. 1/

Features	Style RT26	Style RT10
Min nominal resistance value (ohms)	10	100
Max nominal resistance value (ohms)	2 kΩ	5 kΩ
Max resistance-temperature characteristic (ppm/°C) (Ref to +25°C)	±50	±50
Max ambient temperature at rated wattage	+85°C	+85°C
Max ambient temperature at zero wattage derating	+150°C	+150°C
Power rating (watts)	.250	.750
Setting stability	1 percent + maximum resolution after environmental tests	1 percent + maximum resolution after environmental tests
Max percent change in resistance: 2/		
Thermal shock	1	1
Moisture resistance	1	1
Acceleration	1	1
Shock (specified pulse)	1	1
Vibration, high frequency	1	1
Resistance to soldering heat	1	1
Low-temperature operation	1	1
High-temperature exposure	1	1
Rotational life	2	2
Life	2	2
Resistance tolerance (± percent)	5	5
Peak noise	500 ohms max after environmental tests	500 ohms max after environmental tests
Insulation resistance (megohms):		
Dry	1,000	1,000
Wet (after moisture resistance)	10	10
Dielectric withstanding voltage (volts rms)		
Atmospheric pressure, sea level	600	600
Reduced barometric pressure, 70,000 ft	250	250
Immersion	No continuous bubbles	No continuous bubbles
Operating torque	3 inch-ounces max	8 inch-ounces max
Actual effective-electrical travel	10 turns min 25 turns max	12 turns min 18 turns max

1/ All leads are solderable in accordance with method 208 of MIL-STD-202.

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

SECTION 207

RESISTORS, VARIABLE, NONWIREWOUND (ADJUSTMENT TYPE)

STYLE RJ24

(APPLICABLE SPECIFICATION: MIL-R-22097)

1. SCOPE

1.1 Scope. This section covers multiturn adjustment type and single turn nonwirewound, 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 ±85°C when mounted on a .062-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 two 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.

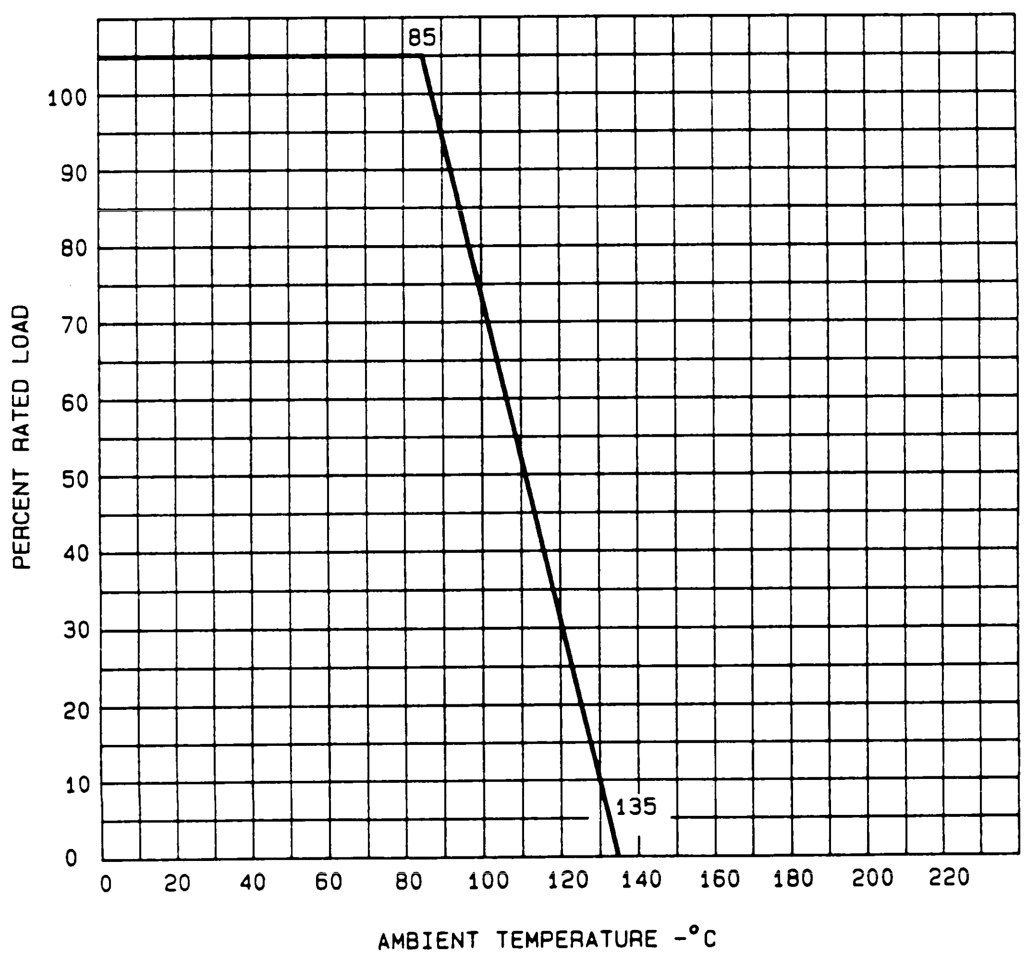


FIGURE 207-1. Derating curves for high ambient temperatures.

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 207-1.

RJ24 C L 103

Style: The two-letter symbol "RJ" identifies adjustment types, nonwirewound, 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 207-1.

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

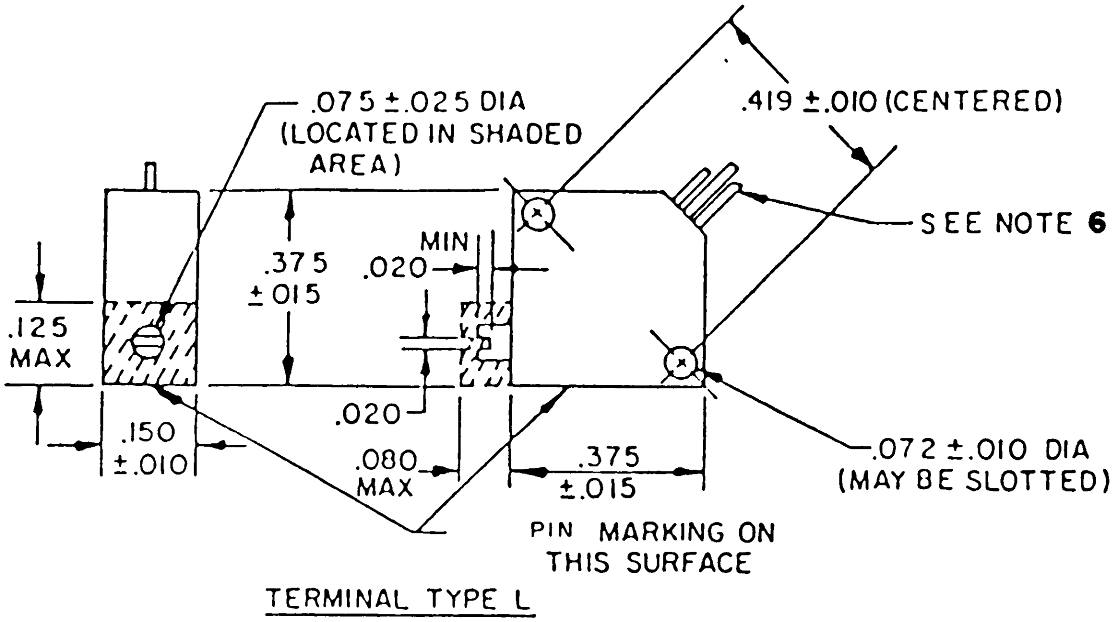
L - - - Flexible, insulated-wire leads

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.



Inches	mm	Inches	mm
.010	0.25	.075	1.91
.015	0.38	.080	2.03
.020	0.51	125	3.18
.025	0.64	.375	9.52
.072	1.83	.419	10.64

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.0005 (0.13 mm).
4. 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.
5. The entire slot of the actuating screw must be above the surface of the unit.
6. The three leads shall be stranded wire, AWG size 28 to 30, having a minimum length of 6.000 (152.4 mm); they shall be insulated with polytetrafluoroethylene, stripped .250 l .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 preterred 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 207-1. Performance characteristics.

Features	Style RJ24 C	Style RJ24 F
Max resistance-temperature characteristic (Percent per °C)	±0.025	±0.010
Max resistance-temperature characteristic (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)	.500	.500
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, NONWIREWOUND

STYLE RVC6

(APPLICABLE SPECIFICATION: MIL-R-23285)

1. SCOPE

1.1 Scope. This section covers nonwirewound, 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.

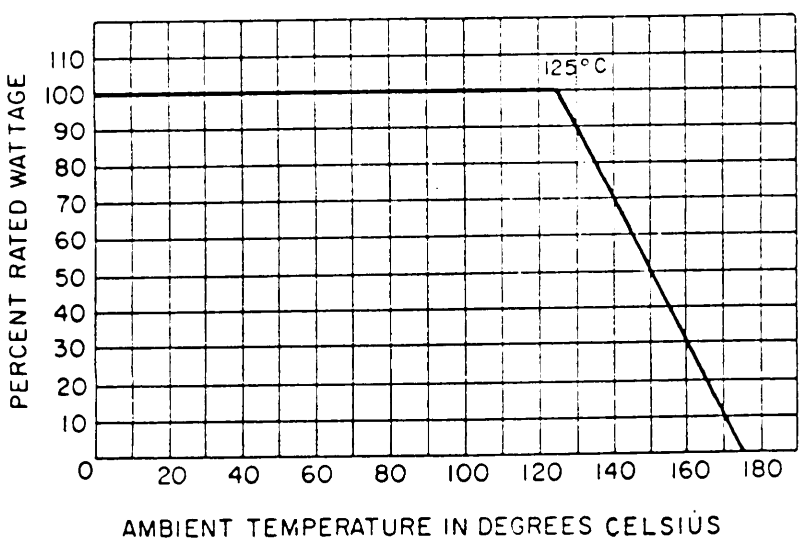


FIGURE 208-1. Derating curve.

2.2.2 Derating for optimum performance. After the anticipated maximum ambient temperature has been determined, a safety factor of two 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 nonlinear resistance taper, which has a variation or lack of constancy in the change of resistance with angular rotation. (See figure 208-2.)

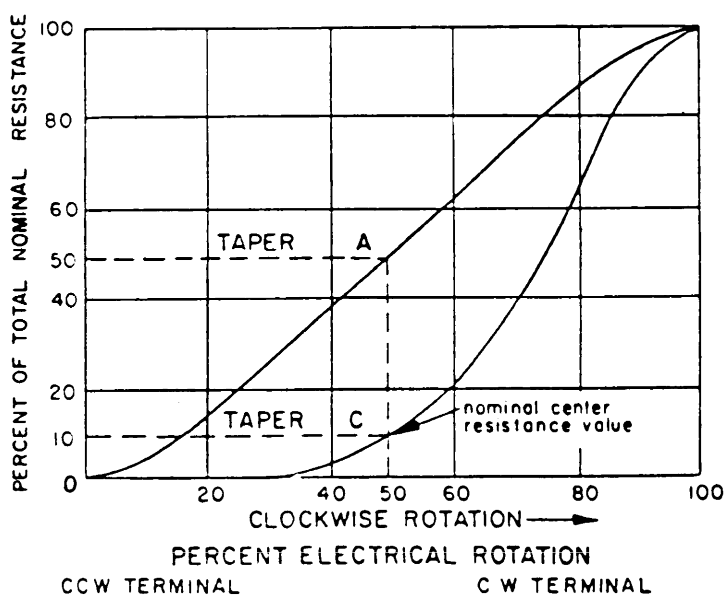


FIGURE 208-2. Clockwise taper.

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 208-1.

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:

Resistance-temperature coefficient - ±250 ppm/°C (see note)

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 - - - .625 inch, screwdriver slot (locking bushing type L)
- D - - - .875 inch, knob (standard bushing type N)
- L - - - .375 inch, screwdriver slot (standard bushing type N)

Resistance: The three-digit number identifies the nominal reisitance 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

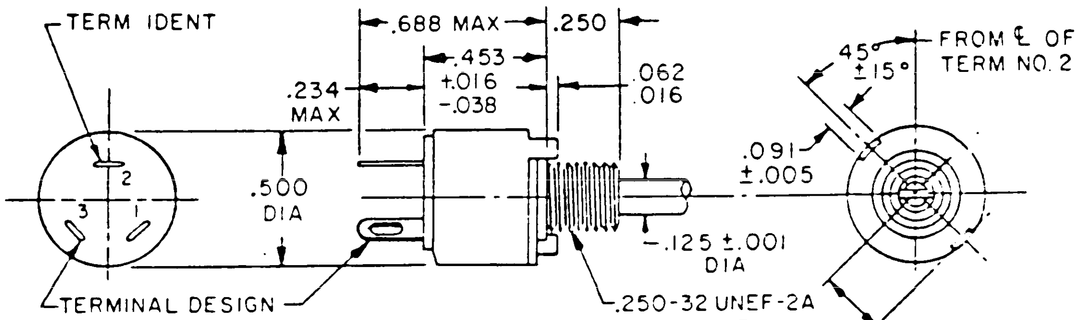
Resistance characteristic: The single-letter symbol identifies the resistance characteristic as follows:

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

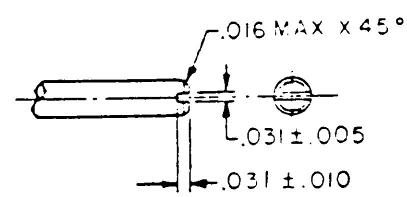
NOTE: Allowable change in resistance at -65°C to +175°C.

FIGURE 208-3. Type designation example.

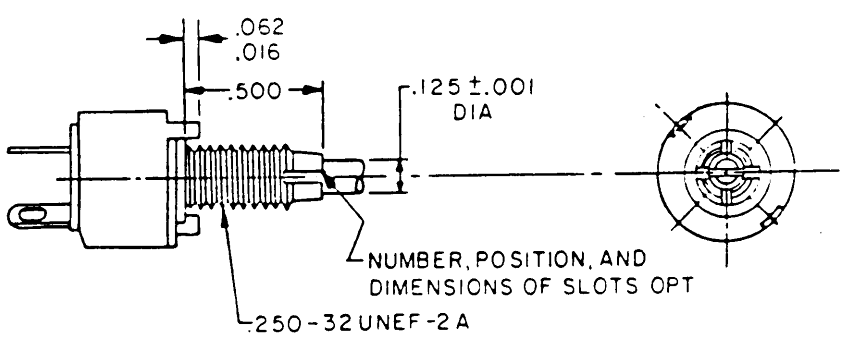
STYLE RV06



Inches	mm	Inches	mm
.001	0.03	.125	3.18
.005	0.13	.234	5.94
.010	0.25	.245	6.22
.016	0.41	.250	6.35
.031	0.79	.453	11.51
.038	0.97	.500	12.70
.062	1.57	.688	17.48
.091	2.31		



SLOTTED SHAFT



LOCKING BUSHING TYPE

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ±.016 (0.41 mm).

FIGURE 208-4. Nonwirewound variable resistors.

TABLE 208-1. Performance characteristics.

Features	RVC6
Type bushing and symbol	Standard (N) Locking (L)
Style shaft Length	Slotted .625 in. (L bushing) .375 and .875 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)	.500 watt (taper A) .250 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, NONWIREWOUND, PRECISION

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

(APPLICABLE SPECIFICATION: MIL-R-39023)

1. SCOPE

1.1 Scope. This section covers precision, nonwirewound, 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.

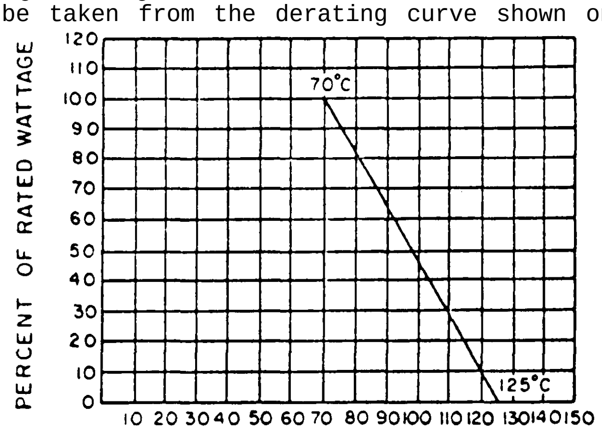


FIGURE 209-1. Derating curves for high ambient temperatures.

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 two 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 269-1.

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

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

* Not available for styles RQ150, RQ200, and RQ300.
** Minimum resistance value for styles RQ100, RQ160, and RQ300.

The maximum value applicable to each style shall be as listed in table 209-1.

RQ090 A A 1 3 A A 101

Style: The two-letter symbol "RQ" identifies precision, nonwirewound, 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.

FIGURE 209-2. Type designation example.

RQ090 A A 1 3 A A 10

Shaft lenght: The single-letter symbol identifies the shaft length (.031 inch) as follows:

A- - - - -	.375	D- - - - -	.750
B- - - - - -	.500	E- - - - - -	.675
C- - - - - -	.625	F - - - - - -	1.000

Moisture resistance: The single-digit number identifies the moisture resistance characteristic (total AR) 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 x 10^5 revolutions; 30 minutes
2 - - - - - 1 x 10^6 revolutions; 2 hours
3 - - - - - 5 x 10^6 revolutions; 10 hours
4 - - - - - 25 x 10^6 revolutions; 50 hours

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_o/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 - Continued.

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

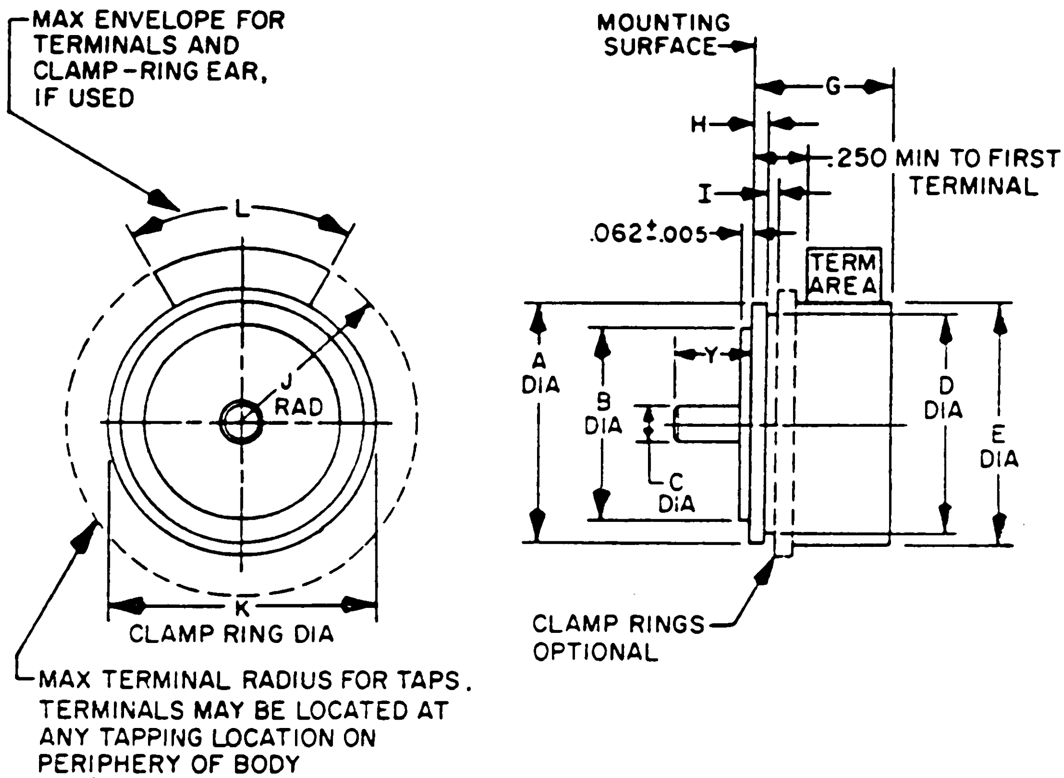


FIGURE 209-3. Nonwirewound, precision, variable resistors.

Style	Dimensions					
	A +.005 (0.13) -.010 (0.25)	B -.0005 (0.01)	C -.0005 (0.01)	D Max	E Max	G Max
RQ090	.875 (22.22)	.7500 (19.05)	.1250 (3.17)	.781 (19.84)	.906 (23.01)	.81 (20.6)
RQ100	.875 (22.22)	.7500 (19.05)	.1250 (3.17)	.781 (19.84)	.906 (23.01)	1.88 (47.7)
RQ110	1.062 (26.97)	.9688 (24.6)	.1250 (3.17)	.975 (24.76)	1.125 (28.57)	.81 (20.6)
RQ150	1.437 (36.50)	1.3125 (33.34)	.2500 (6.35)	1.313 (33.35)	1.468 (37.29)	1.06 (26.9)
RQ160	1.437 (36.50)	1.3125 (33.34)	"	1.313 (33.35)	1.468 (37.29)	2.50 (63.5)
RQ200	2.000 (50.80)	1.8750 (47.62)	"	1.875 (47.62)	2.031 (51.59)	1.31 (33.3)
RQ210	2.000 (50.80)	1.8750 (47.62)	"	1.875 (47.62)	2.031 (51.59)	2.90 (73.7)
RQ300	3.000 (76.20)	2.8750 (73.02)	"	2.875 (73.02)	3.031 (76.97)	1.31 (33.3)

FIGURE 209-3. Nonwirewound, precision, variable resistors - Continued.

Style	Dimensions				
	H ±.005 (0.13)	I Min	J Max	K Max	L Max
RQ090	.062 (1.57)	.057 (1.45)	.656 (16.66)	1.062 (26.97)	105°
RQ100	.062 (1.57)	.057 (1.45)	.656 (16.66)	1.062 (26.97)	105°
RQ110	.062 (1.57)	.057 (1.45)	.781 (19.84)	1.125 (28.57)	100°
RQ150	.093 (2.36)	.073 (1.85)	1.094 (27.79)	1.625 (41.27)	"
RQ160	"	"	1.094 (27.79)	1.625 (41.27)	"
RQ200	"	"	1.375 (34.92)	2.250 (57.15)	"
RQ210	"	"	1.375 (34.92)	2.250 (57.15)	"
RQ300	"	"	1.750 (44.45)	3.250 (82.55)	90°

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

FIGURE 209-3. Nonwirewound, precision, variable resistors - Continued.

TABLE 209-1. Performance characteristics.

Features	Style							
	RQ090	RQ100	RQ110	RQ150	RQ160	RQ200	RQ210	RQ300
Shaft length	.375, .500, .625, .750, .375, .500, .625, .750, .875, 1.000							
Diameter	.125	.125	.125	.125	.250	.250	.250	.250
Cup diameter	.875	.875	1.062	1.437	1.437	2.000	2.000	3.000
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

Features	All styles
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

1.1 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 O 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 .500 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 two 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.

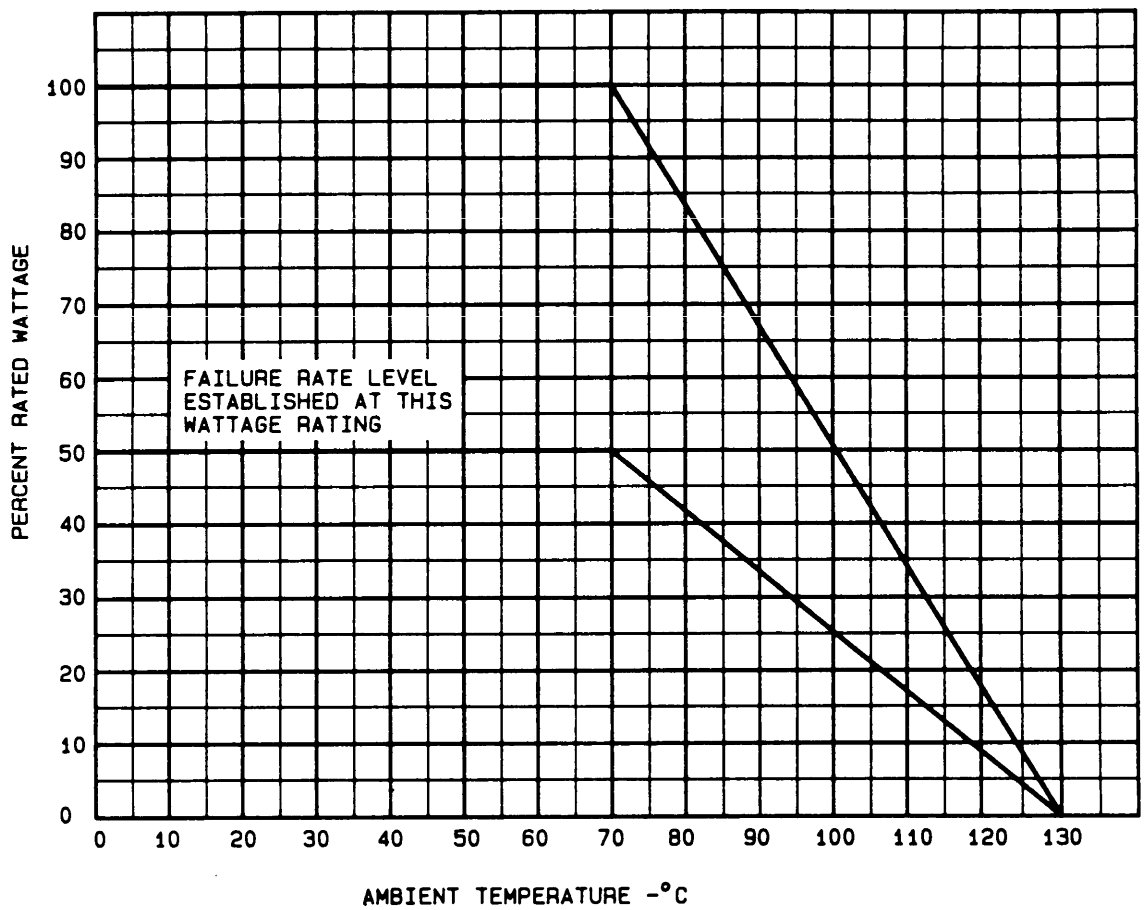
TABLE 301-1. Resistance-temperature characteristic.

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 301-11, 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 301-11. Maximum overload voltage.

Power rating	Maximum overload voltage (dc or peak ac)
Watts	Volts
.125	200
.250	400
.300	700
1.000	1,000
2.000	1,000



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.

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 microvolt 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.

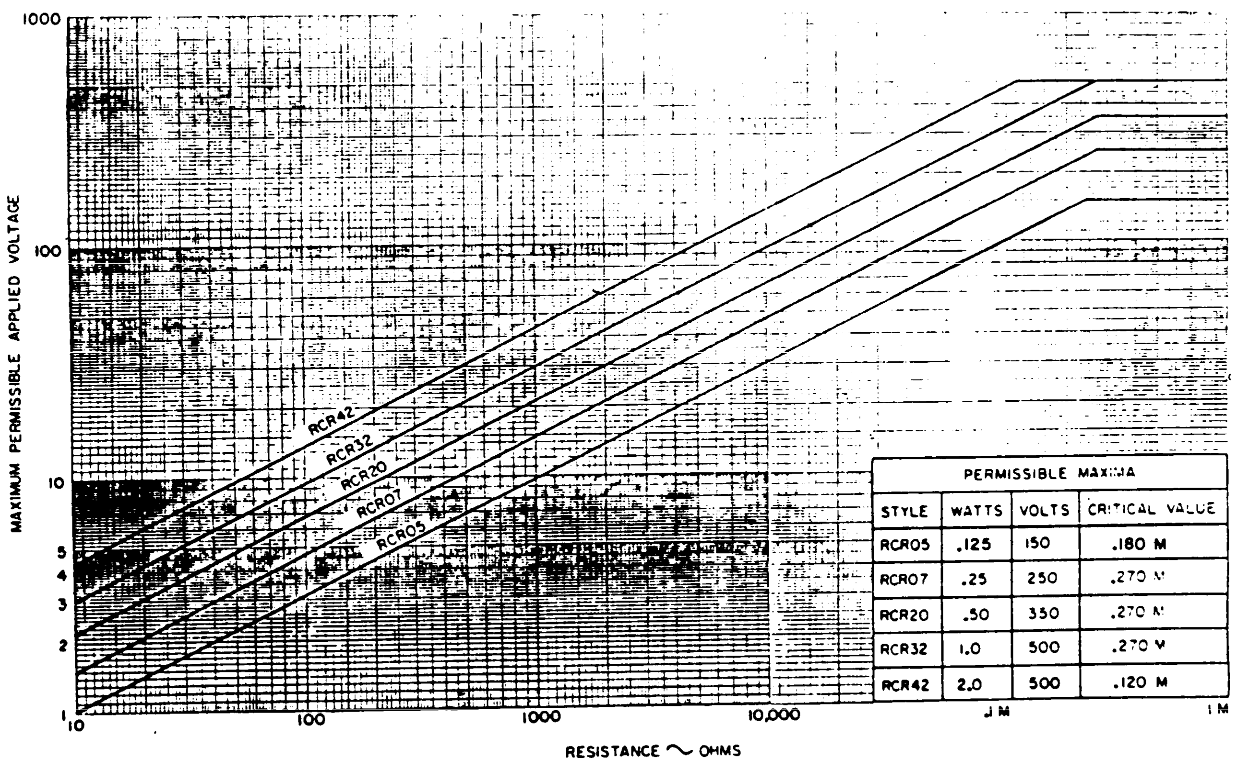
2.8 Maximum rated voltage. The fact that there are voltage limits in the application of fixed composition resistors is often overlooked. These maximum rated applied voltages, which are imposed because of insulation breakdown problems, must be taken into consideration in addition to the limitations of 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 .125 watt, .250 watt, .500 watt, 1 watt, and 2 watts 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 in accordance with 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 .250 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 O 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	---

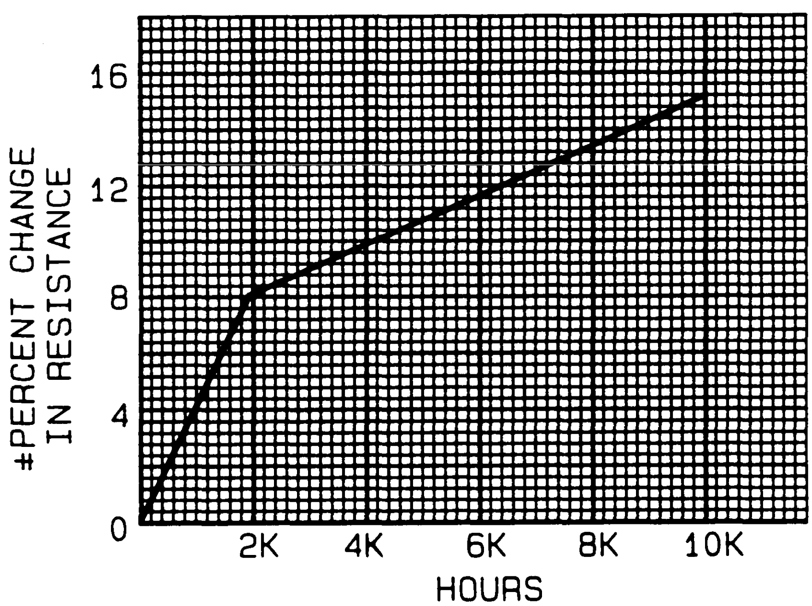


FIGURE 301-3. Life test degradation curve.

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 is shown in table 301-1.

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:

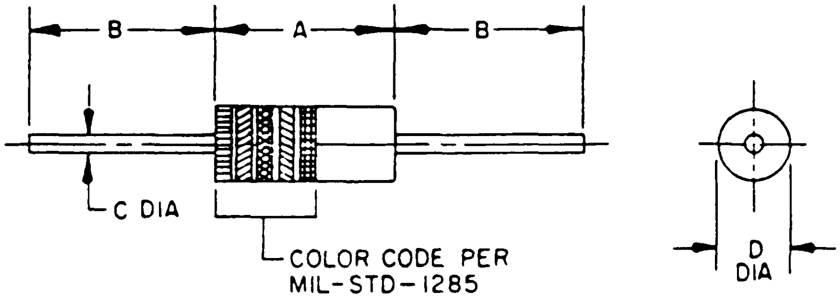
J - - - -	±5 percent
K - - - -	±10 percent

Failure rate level: The single-letter symbol identifies the failure rate as follows:

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

FIGURE 301-4. Type designation example.

STYLES RCR05, RCR07, RCR20, RCR32, AND RCR42



Inches	mm	Inches	mm
.002	0.05	.062	1.57
.003	0.08	.090	2.29
.004	0.10	.125	3.18
.005	0.13	.138	3.51
.008	0.20	.145	3.68
.015	0.38	.225	5.72
.018	0.46	.250	6.35
.023	0.58	.318	8.08
.025	0.64	.375	9.53
.031	0.79	.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. 1/

Features	Style				
	RCR05	RCR07	RCR20	RCR32	RCR42
Power rating (at +70°C):					
100 percent load (watts)	.125	.250	.500	1.000	2.000
50 percent load/FR level determination (watt)	.062	.125	.250	.500	1.000
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 (max +ΔR percent/volt) 2/	0.05	0.035	0.035	0.02	0.02
Max percent change in resistance (±): 3/					
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 hours)	10	10	10	10	10
50 percent wattage (2,000 hours)	8	8	8	8	8
Failure rate determination (10,000 hours)	15	15	15	15	15

1/ All leads are solderable in accordance with method 208 of MIL-STD-202.
2/ Applicable only to resistors of 1,000 ohms and over.
3/ Where total resistance change is 4 percent or less, it shall be considered as ±(____percent +0.05 ohm).

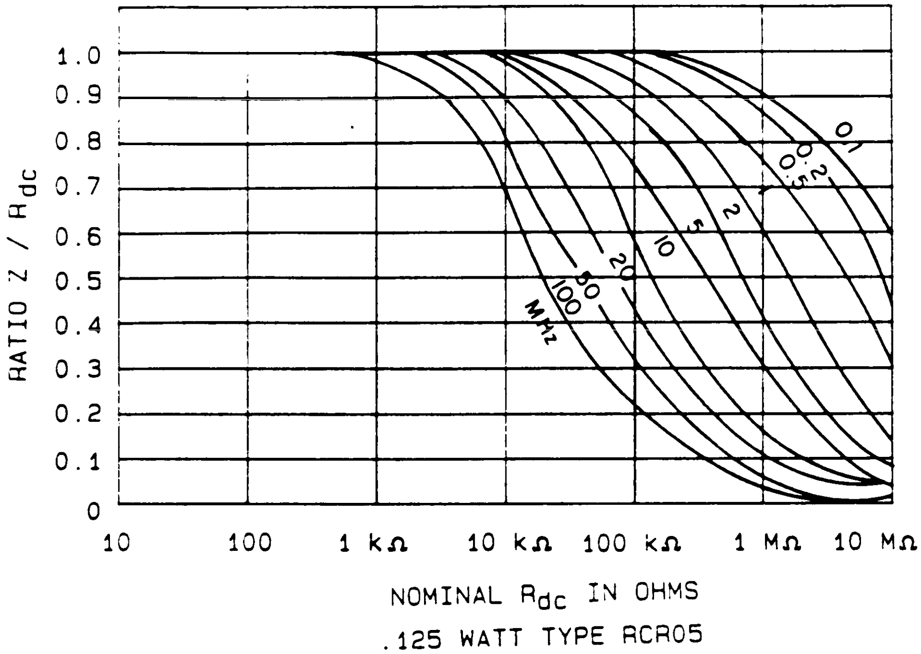


FIGURE 301-6. Impedance to dc resistance ratio.

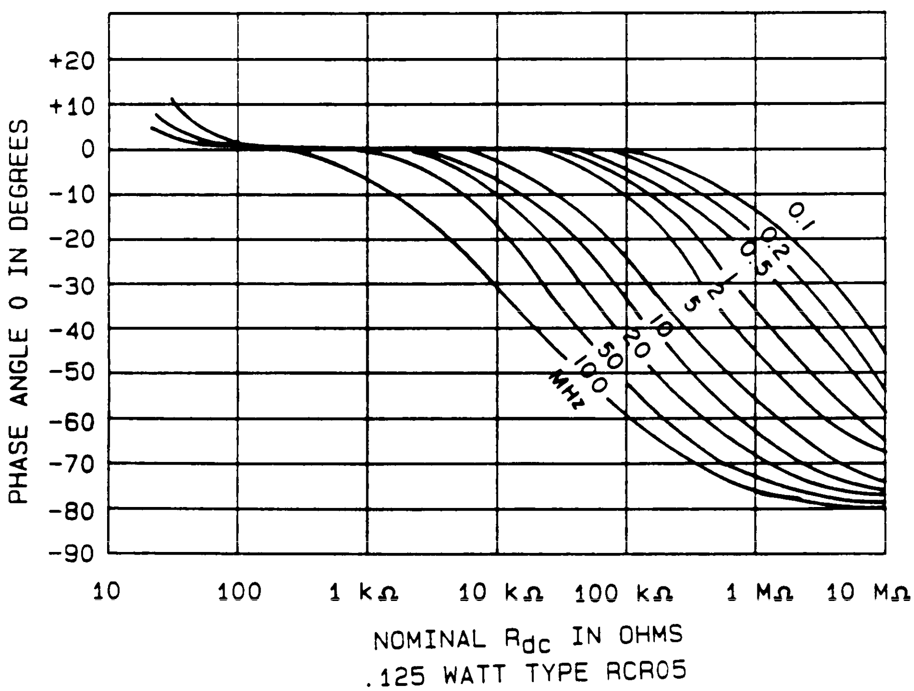


FIGURE 301-7. Impedance to phase angle.

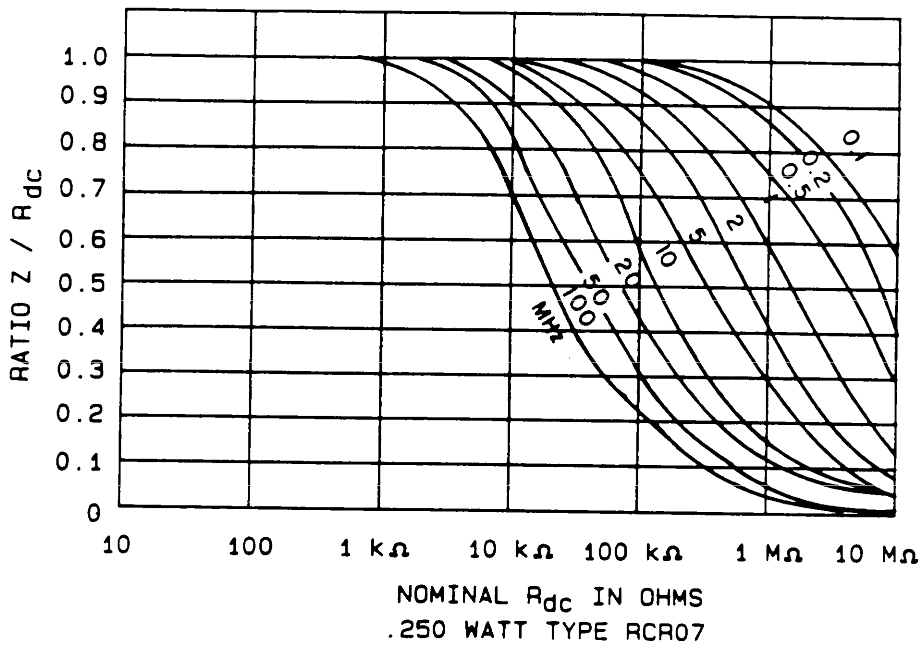


FIGURE 301-8. Impedance to dc resistance ratio.

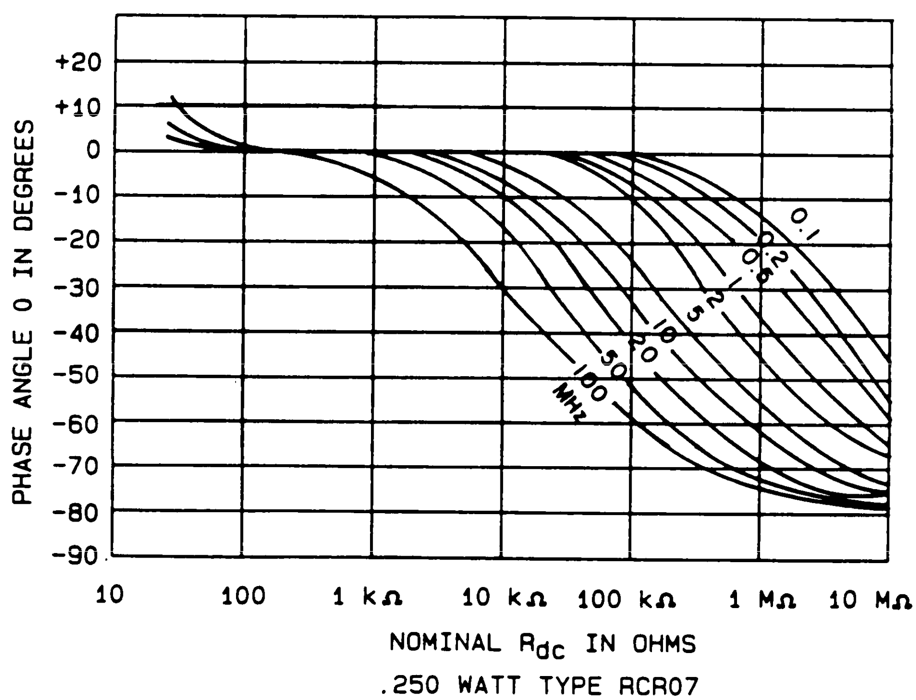


FIGURE 301-9. Impedance to phase angle.

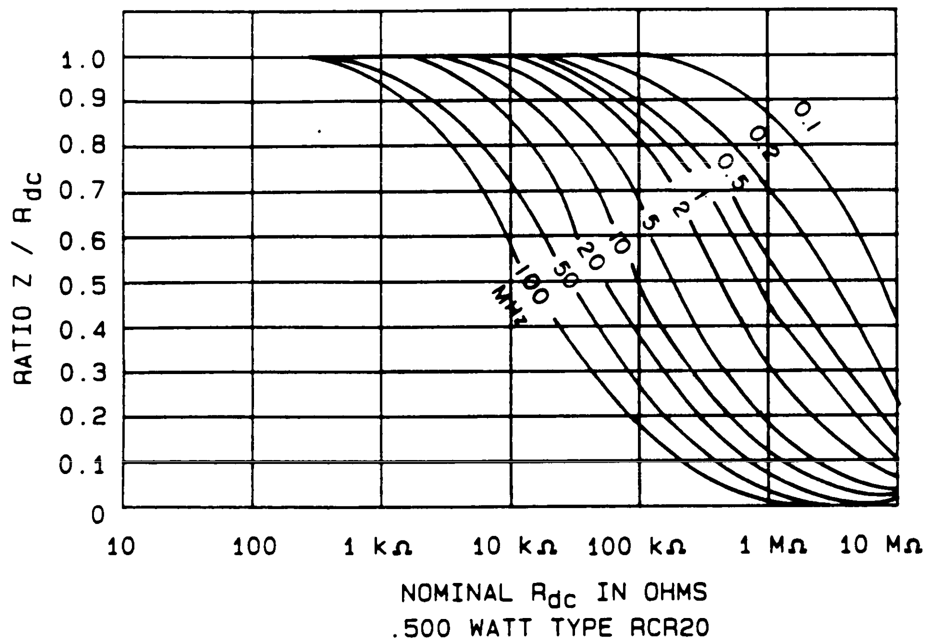
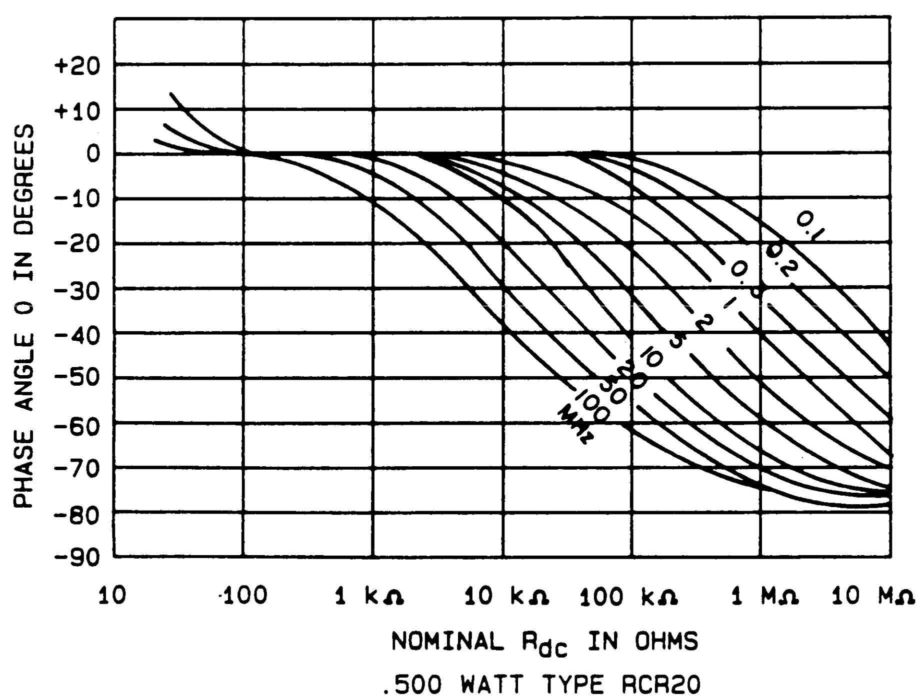


FIGURE 301-10. Impedance to dc resistance ratio.



301-11. Impedance to phase angle.

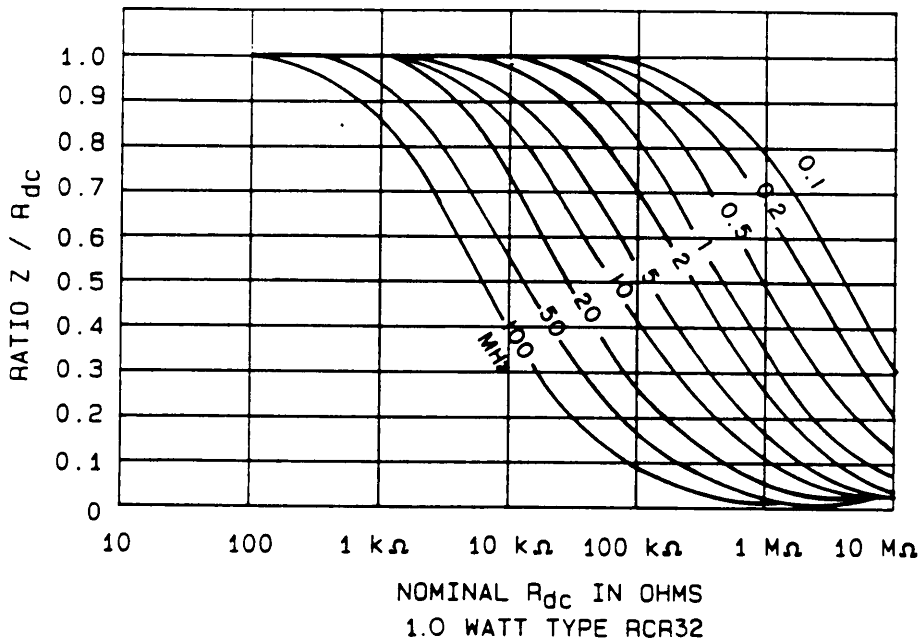
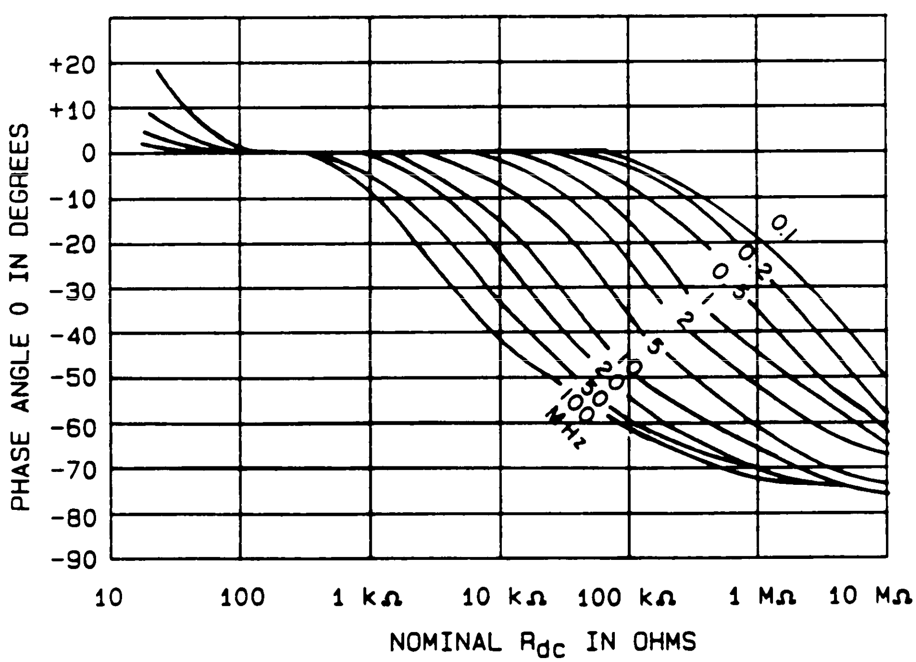


FIGURE 301-12. Impedance to dc resistance ratio.



301-13. Impedance to phase angle.

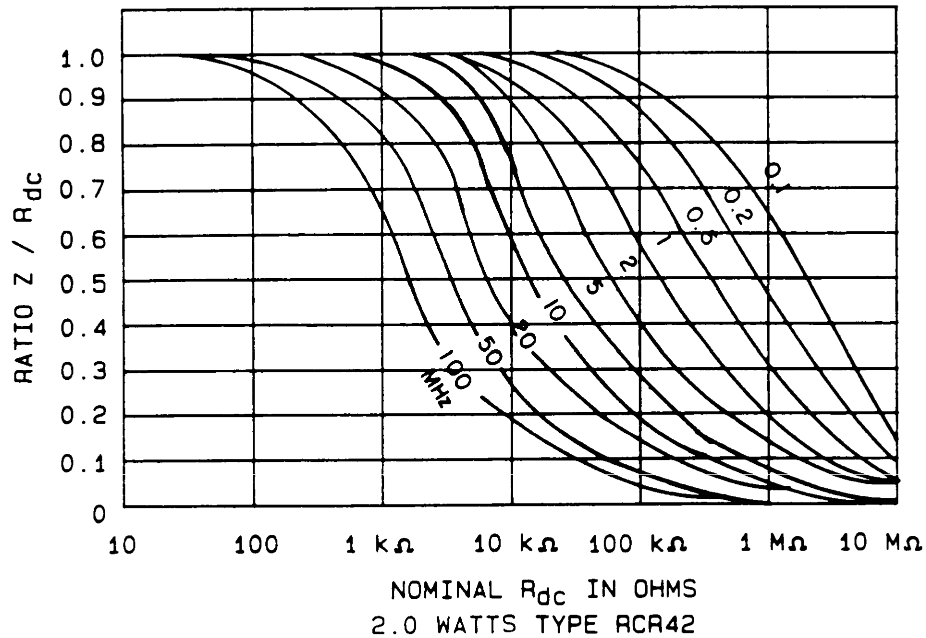


FIGURE 301-14. Impedance to dc resistance ratio.

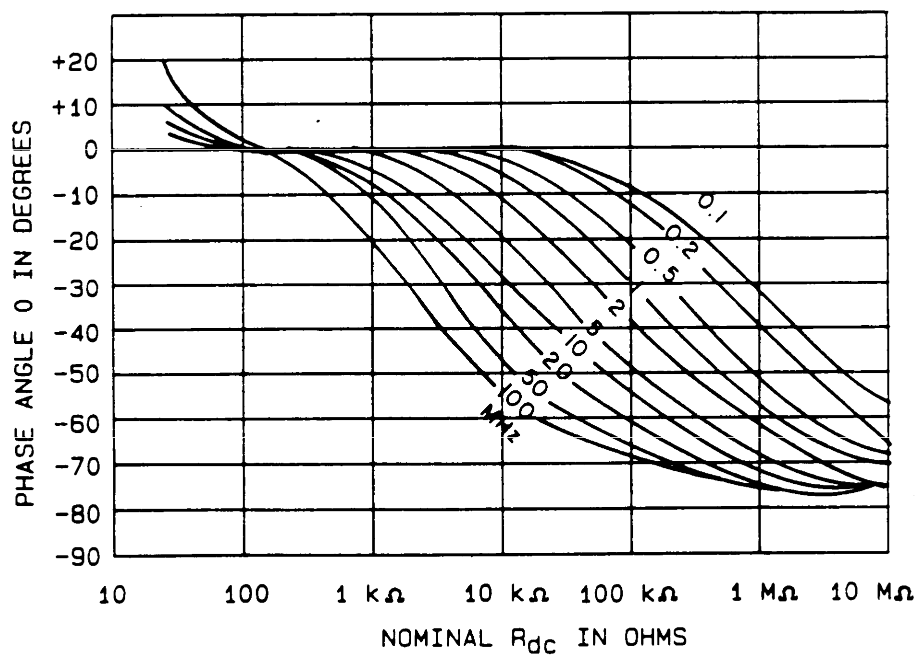


FIGURE 301-15. Impedance to phase angle.

SECTION 302

RESISTORS, FIXED, FILM, ESTABLISHED RELIABILITY

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

(APPLICABLE SPECIFICATION: MIL-R-55182)

1. SCOPE

1.1 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 O 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.

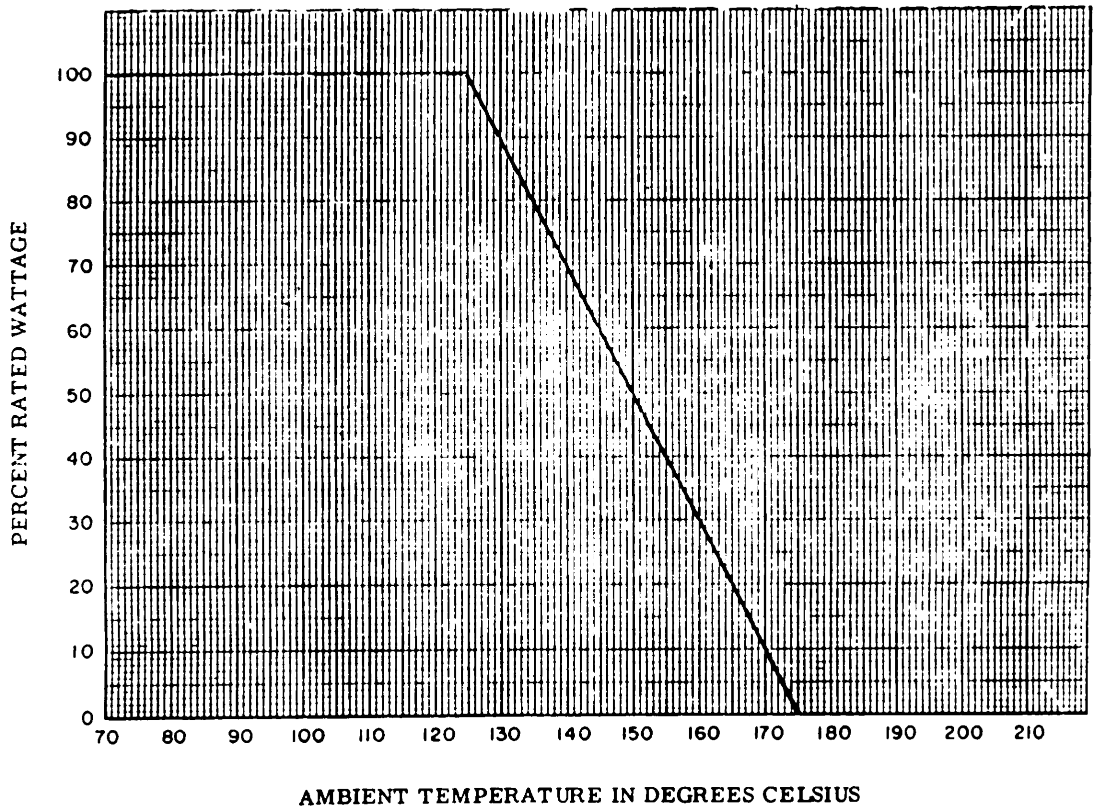
2. APPLICATION INFORMATION

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 spiraling 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 two, applied to the wattage, is recommended in order to insure the selection of a resistor having an adequate wattage-dissipation potential.

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 that +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.

2.4 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.

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 O 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.

2.13 Terminal substitution data. Hermetically sealed resistors (characteristics C and E, with terminal R) are a direct one-way substitute for hermetically sealed resistors (characteristics H, J, and K with termination C), provided all other characteristics are equal or better.

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 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 (see table 302-1).

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in talbe 302-II.

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

Char-acter-istic	Terminal designator	Specification indicates weldable	Specification indicates solderable
C	N (Type N-22 of MIL-STD-1276), R	N - Yes R - No	N - No R - Yes
H	C (Type C31, C32, or C52 of MIL-STD-1276)	Yes	Yes
E	N (Type N-22 of MIL-STD-1276), R	N - Yes R - No	N - No R - Yes
J	C (Type C31, C32, or C52 of MIL-STD-1276)	Yes	Yes
K	C (Type C31, C32, or C52 of MIL-STD-1276)	Yes	Yes
Y 1/	C (Type C31, C32, or C52 of MIL-STD-1276)	Yes	Yes

1/ Applicable to style RNC90 only

Symbol	Terminal
RNR 1/	Solderable
RNC 2/	Solderable/weldable (type C31, C32, or C52 of MIL-STD-1276)
RNN	Weldable (type N-22 of MIL-STD-1276)

1/ Terminal R is inactive for design when specified with characteristics H, J, and K.
2/ RNC terminals are substitutable for terminal type RNR (see 2.13).

TABLE 302-I. 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	---

TABLE 302-I. Resistance tolerance - continued

D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)	D (0.5)	F (1.0)
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 he characteristic (as specified in table 302-1) as follows:

C - - - - ±50 ppm/°C; +125°C max ambient temperature at rated wattage 1/
H - - - - ±50 ppm/°C; +125°C max ambient temperature at rated wattage
E - - - - ±25 ppm/°C; +125°C max ambient temperature at rated wattage 1/
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 hours
P - - - - - 0.1 percent/1,000 hours
R - - - - - 0.01 percent/1,000 hours
S- - - -- 0.001 percent/1,000 hours

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 302-11) 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 rester, 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:

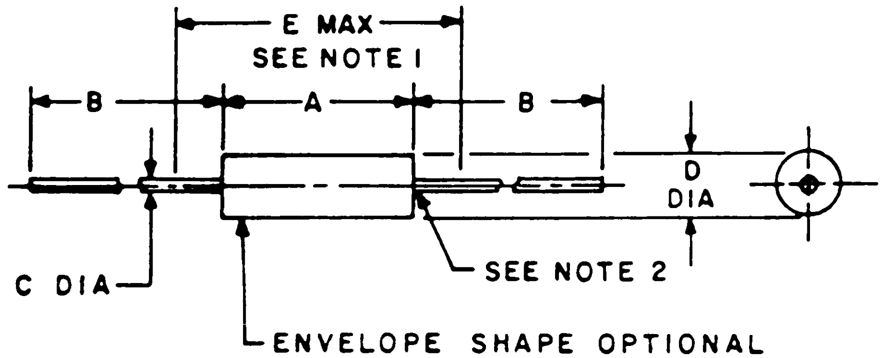
V - - - ±.005 percent resistance tolerance
T - - - ±.01 percent resistance tolerance
A - - - ±.05 percent resistance tolerance
B - - - ±0.1 percent resistance tolerance
D - - - ±0.5 percent resistance tolerance
F - - - ±1.0 percent resistance tolerance

Life failure rate designation: The single-letter symbol identifi es the life failure rate as follows:

M- - - -- 1.0 percent/1,000 hours
P - -- -- 0.1 percent/1,000 hours
R - - - - - 0.01 percent/1,000 hours
s - - - - - 0.001 percent/1,000 hours

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

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



Inches	mm	Inches	mm
.002	0.05	.062	1.57
.003	0.08	.090	2.29
.004	0.10	.125	3.18
.005	0.13	.138	3.51
.008	0.20	.145	3.68
.015	0.38	.225	5.72
.018	0.46	.250	6.35
.023	0.58	.318	8.08
.025	0.64	.375	9.53
.031	0.79	.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 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

1/ Lead length for tape and reel packaging shall be 1 inch minimum.

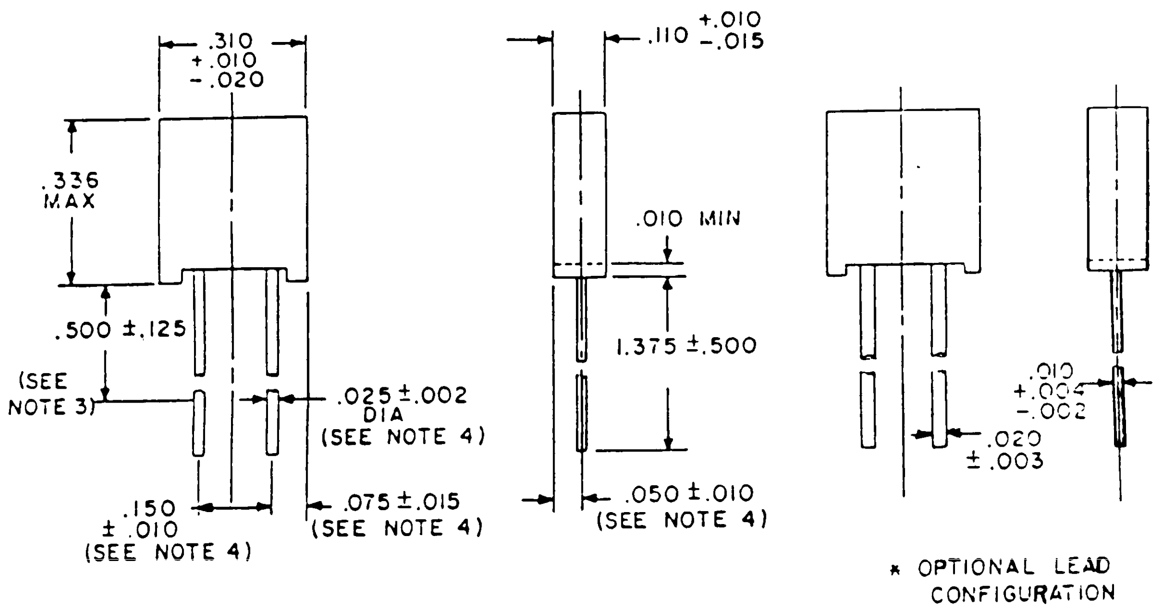
2/ For characteristics C, E, dimensions A = .180 +.020.

* 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	0.05	.075	1.91
.003	0.08	.110	2.79
.004	0.10	.125	3.18
.010	0.25	150	3.81
.015	0.38	.310	7.87
.020	0.51	.336	8.53
.025	0.64	.500	12.70
.050	1.27	1.375	34.92

NOTES:
1. Dimensions 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-II. 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 1/
Parts per million/°C	±50	±50	±25	±25	±100	±5
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	.050 W, 200 V	.050 W, 200 V	.050 W, 200 V	.050 W, 200 V	.050 W, 200 V	Not available
Style RNR55	.100 W, 200 V	.100 W, 200 V	.100 W, 200 V	.100 W, 200 V	.100 W, 200 V	Not available
Style RNR60	.125 W, 250 V	.125 W, 250 V	.125 W, 250 V	.125 W, 250 V	.125 W, 250 V	Not available
Style RNR65	.253 W, 300 V	.250 W, 300 V	.250 W, 300 V	.250 W, 300 V	.250 W, 300 V	Not available
Style RNR70	.500 W, 350 V	.500 W, 350 V	.500 W, 350 V	.500 W, 350 V	.500 W, 350 V	Not available
Style RNR75	Not available	Not available	1 W, 750 V	1.000 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	.100 W, 200 V	.100 W, 200 V	.100 W, 200 V	.100 W, 200 V	.100 W, 200 V	Not available
Style RNR55	.125 W, 200 V	.125 W, 200 V	.125 W, 200 V	.125 W, 200 V	.125 W, 200 V	Not available
Style RNR60	.250 W, 300 V	.250 W, 300 V	.250 W, 300 V	.250 W, 300 V	.250 W, 300 V	Not available
Style RNR65	.500 W, 350 V	.500 W, 350 V	.500 W, 350 V	.500 W, 350 V	.500 W, 350 V	Not available
Style RNR70	.750 W, 500 V	.750 W, 500 V	.750 W, 500 V	.750 W, 500 V	.750 W, 500 V	Not available
Style RNR75	Not available	Not available	2.000 W, 750 V	2.000 W, 750 V	Not available	Not available
Style RNC90	Not available	Not available	Not available	Not available	Not available	.6 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 / 200 kΩ
Max percent change in resistance values: 4/						
Temperature cycling	0.2	0.2	0.2	0.2	0.2	0.05
Overload						
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	5/	5/	5/	5/	5/	6/
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-hour duration); ±2.0 percent (10,000-hour duration).

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

1.1 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 O 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 303-1.

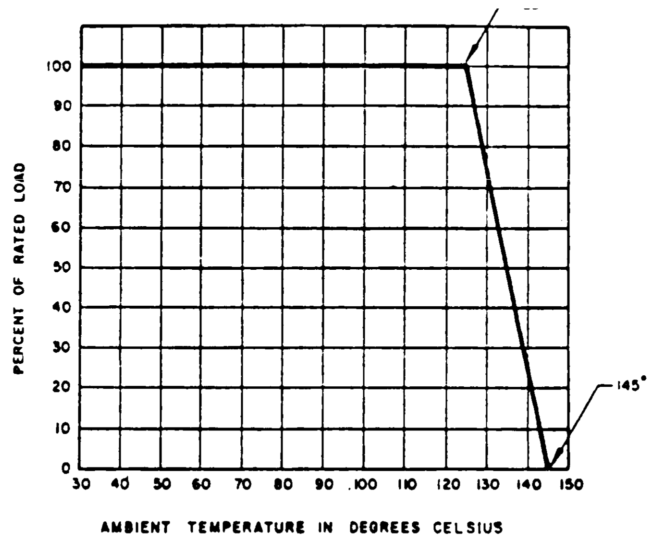


FIGURE 303-1. Derating curve for high ambient temperature.

TABLE 303-1. Resistance tolerance and wattage input.

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

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

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 two, 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. 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 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 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 (see table 303-1).

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

TABLE 303-1. 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 AR requirement as follows:

L - ------ Solderable (tightened AR)
u - ------ Weldable (tightened AR)

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

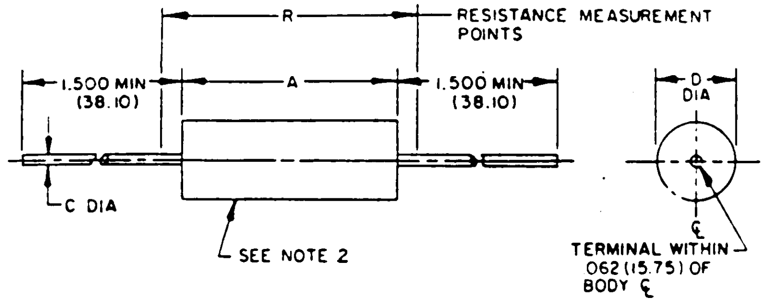
Life failure rate: The single-letter symbol identifies the life failure rate as follows:

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

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 (inches)			
	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. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Envelope-essentially cylindrical, no square or rectangular sections.
4. Dimension A is “clean lead” to “clean lead”.
5. Metric equivalents are in parenthesis.

STYLE RBR71

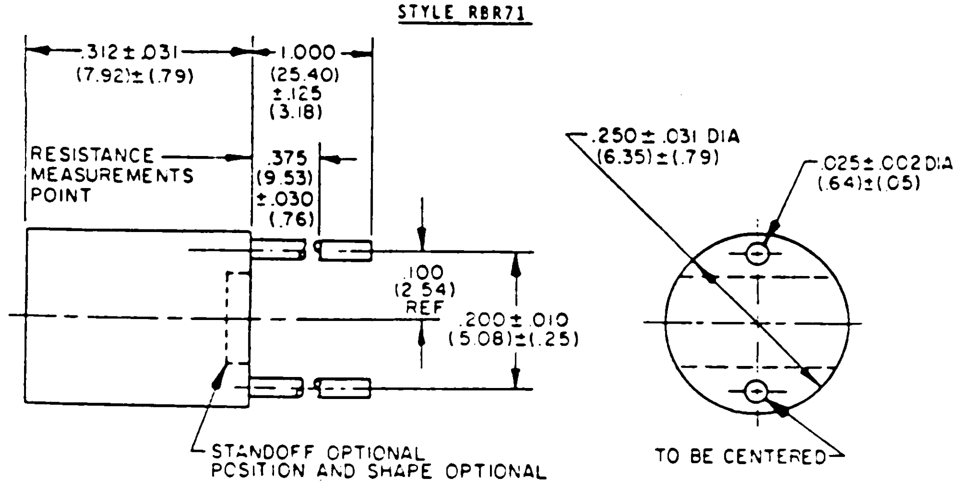


FIGURE 303-3. Establish reliability, wirewound (accurate), fixed resistors.

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		.500 watt 600 volts	.333 watt 300 volts	.250 watt 300 volts	.15 watt 200 volts	.125 watt 150 volts	.750 watt 600 volts	.125 watt 150 volts	.125 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 hours)		.1	.1	.1	.1	.1	.1	.1	.1
Failure rate determination (10,000 hours)		.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

1.1 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 two, 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.

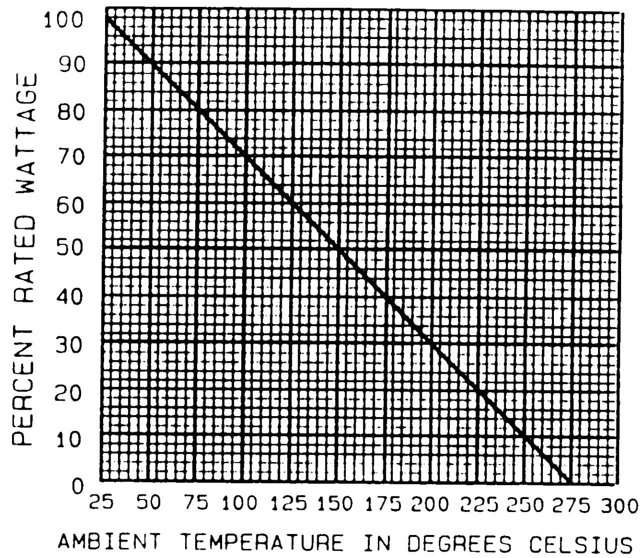


FIGURE 304-1. Derating curve for high ambient temperature.

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.

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.
lengths should be kept as short as possible, .250 inch or less preferred, but no longer than .625 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:

Styles 1/	Maximum effective series inductance = μH		Maximum effective parallel capacitance - pF
	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 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 (see table 304-1).

3.3 Performance characteristics. Performance characteristics are shown in table 304-11.

TABLE 304-1. 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:

1ROO- - - - - 1 ohm
1ORO- - - - - 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:

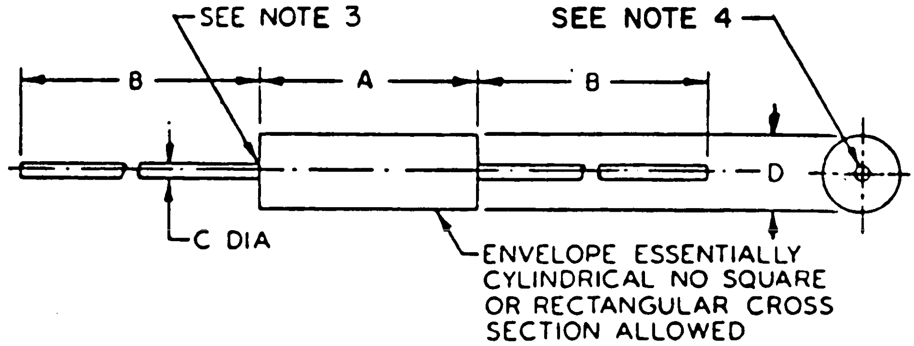
B - - - - - ±0.1 percent
D - - - - - ±0.5 percent
F - - --- ±1.0 percent

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

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

FIGURE 304-2. Type designation example.

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



Style	Dimensions (inches)			
	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)

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Dimension A is "clean lead" to "clean lead".
4. Lead concentric tolerance is to be measured at the point of lead egress from the resistor body to be within .016 TIR for styles RWR80, RWR81, and RWR89, and .032 TIR for styles RHR78, RWR82, RWR84, and RWR89.

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

TABLE 304-11. Performance characteristics.

Features		RWR78	RWR80	RWR81	RWR82 1/	RWR84	RWR89
Max resistance-temperature in ppm/°C characteristic (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 hours)		0.5	0.5	0.5	0.5	0.5	0.5
Failure rate determination (10,000 hours)		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 reactance 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

1.1 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.

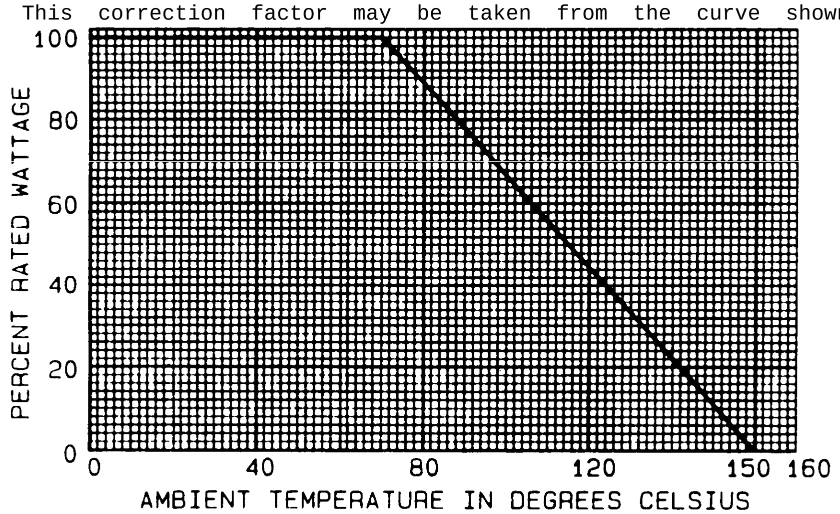


FIGURE 305-1. Derating curve for high ambient temperature.

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.

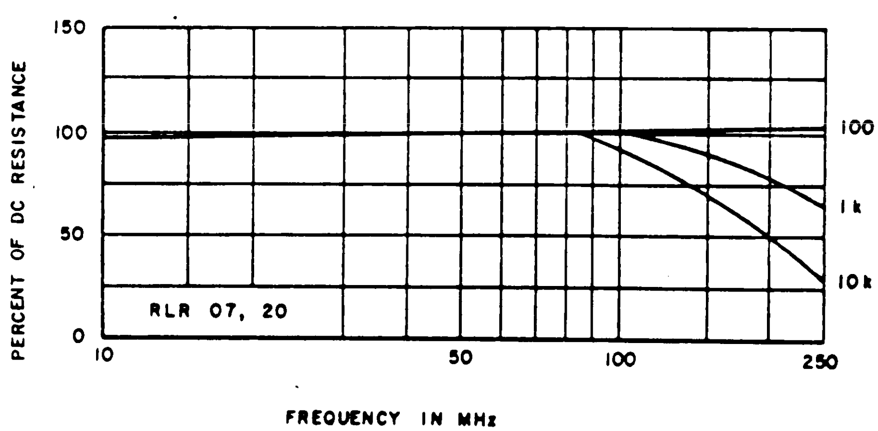


FIGURE 305-2. Response curve.

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 hours
P - - - - 0.1 percent/1,000 hours
R - - - - 0.01 percent/1,000 hours
S - - - - 0.001 percent/1,000 hours

FIGURE 305-3. Type designation example.

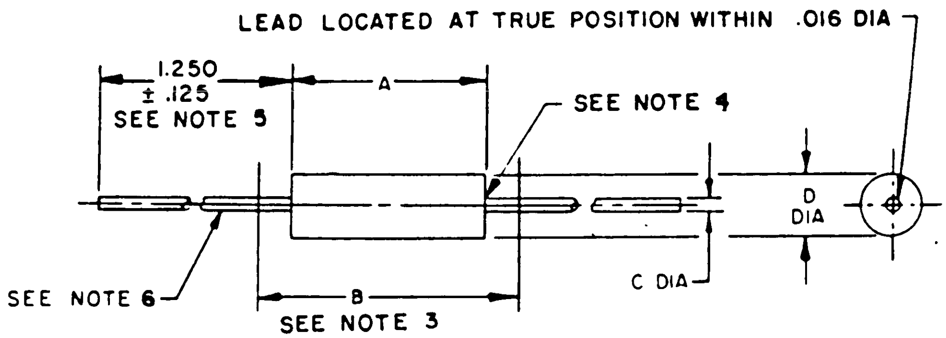
3.2 Resistance values. The standard resistance values specified shall follow the decade of values shown in the following tabulation (see table 305-I):

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in table 305-II.

TABLE I 305-I. 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	0.03	.023	0.58	.064	1.63	.318	8.08
.002	0.06	.025	0.64	.066	1.68	.375	9.53
.006	0.15	.031	0.79	.090	2.29	.380	9.65
.008	0.20	.032	0.81	.125	3.18	.450	11.43
.015	0.38	.040	1.02	.138	3.51	.562	14.27
.016	0.41	.041	1.04	.150	3.81	.625	15.88
.018	0.46	.042	1.07	.187	4.75	.688	17.48
.020	0.51	.045	1.14	.190	4.83	.756	19.20
		.046	1.17	.250	6.35	1.250	33.75
				.300	7.62		

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Maximum length is “clean lead” to “clean lead”.
4. 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.
5. Length is 1.250 (31.75 mm) ±.266 (6.76 mm) for style RLR05.
6. Lead length for tape and reel packaging shall be 1 inch minimum.

FIGURE 305-4. Established reliability, fixed film resistors (insulated).

TABLE 305-1. 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)	30	22.1	3.01	2.7
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)	0.5	0.5	0.5	0.5
Vibration, high frequency				
High temperature exposure	2.0	2.0	2.0	2.0
Life:				
Initial qualification (2,000 hours)	2.0	2.0	2.0	2.0
Failure rate determination (10,000 hours)	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

1.1 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.O 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.O percent at O 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 two applied to the wattage is recommended in order to insure the selection of a resistor having an a equate 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:

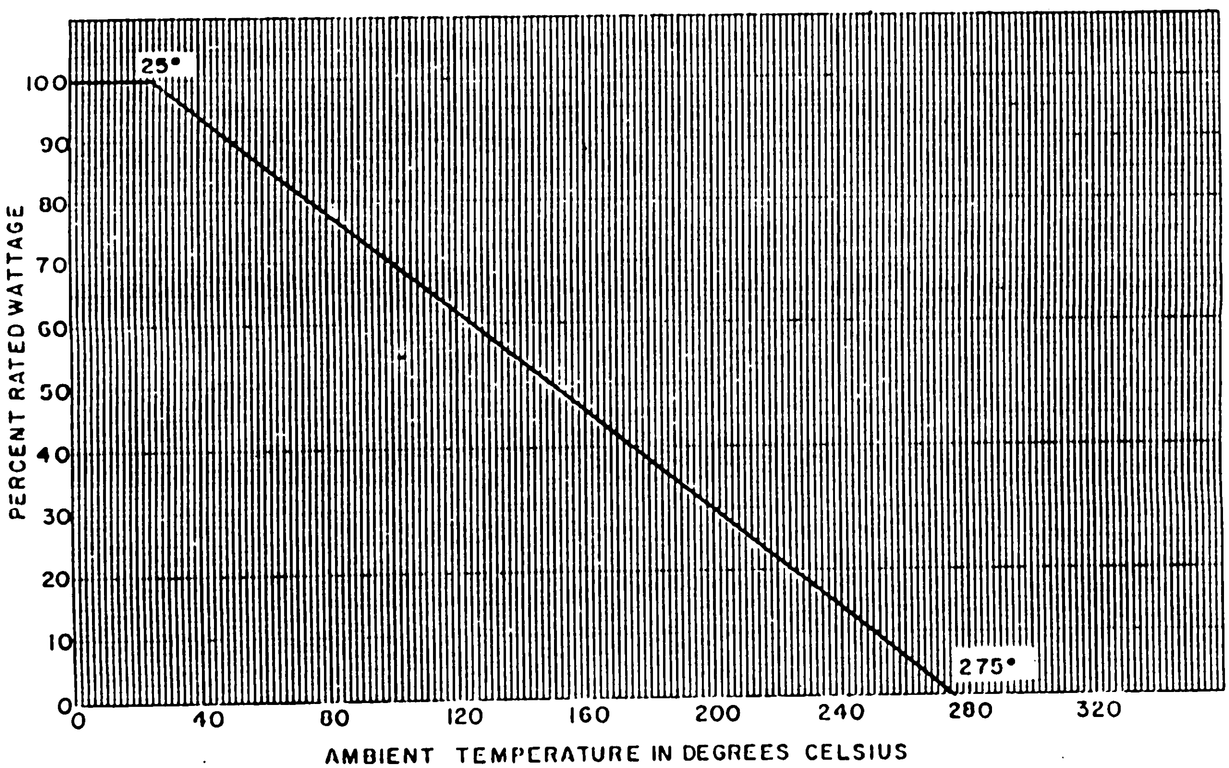
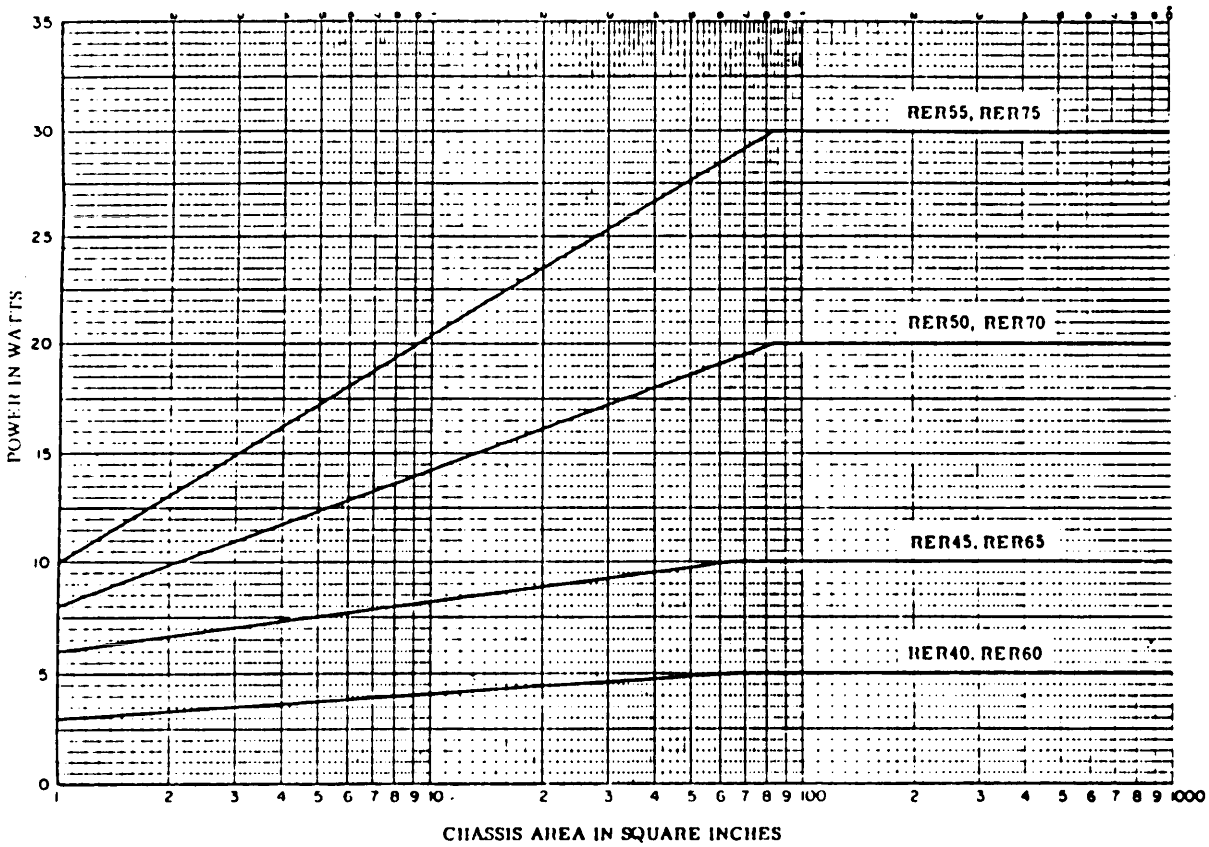


FIGURE 306-1. Derating curve for high ambient temperature.



NOTE: The chasis 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.

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.

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	RER60 - - - - - -	3 grams
RER45 - - - - - -	8.8 grams	RER65 - - - - - -	8 grams
RER50 - - - - - -	16.5 grams	RER70 - - - - - -	15 grams
RER55 - - - - - -	35 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 percent)						
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 estalished 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:

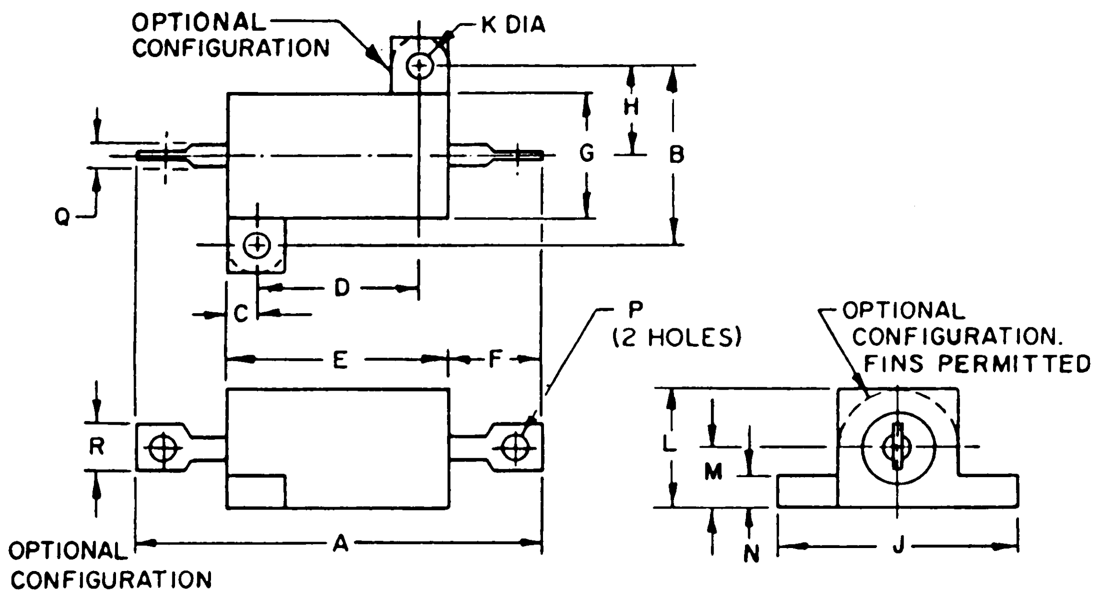
R100- - - - - 0.10 ohm
1R00- - - - - 1.0 ohm
10R0- - - - - 10 ohms
1000- - - - - 100 ohms
1001- - - - - 1,000 ohms

Failure rate level: The single-letter symbol identifies the failure rate as follows:

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

FIGURE 306-3. Type designation example.

STYLES RER40, RER45, RER50, RER55, RER60, RER65, RER70, AND RER75



Resis-tor style	A ±.062 (1.57)	B ±.010 (0.25)	C ±.031 (0.79)	D ±.010 (0.25)	E ±.062 (1.57)	F ±.062 (1.57)	G ±.062 (1.57)	H ±.031 (0.79)
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)
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)
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)
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)

FIGURE 306-4. Established reliability, wirewound (power type, chassis mounted), fixed resistors.

STYLES RER40, RER45, RER50, RER55, RER60, RER65, RER70, AND RER75

Resistor style	J ±.031 (0.79)	K ±.005 (0.13)	L ±.031 (0.79)	M ±.062 (1.57)	N ±.031 (0.79)	P ±.005 (0.13)	Q min AWG	R min
RER40 RER60	.646 (16.41)	.093 (2.36)	.320 (8.13)	.133 (3.38)	.065 (1.65)	.050 (1.27)	16	.085 (2.16)
RER45 RER65	.812 (20.62)	.094 (2.39)	.406 (10.31)	.203 (5.16)	.094 (2.39)	.085 (2.16)	12	.140 (3.56)
RER50 RER70	1.094 (27.79)	.125 (3.18)	.562 (14.27)	.281 (7.14)	.094 (2.39)	.085 (2.16)	12	.140 (3.56)
RER55 RER75	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 - Continued.

TABLE 306-1. 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 (6,400)	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 hours)		1.0	1.0	1.0	1.0
Failure-rate determination (10,000-hours)		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, -.250	5, +0, -.250	5, +0, -.250	5, +0, -.250

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, RM1005, RM1505, RM2208, RM0705, RM1206, RM2010, RM2512, AND RM1010

(APPLICABLE SPECIFICATION: MIL-R-55342)

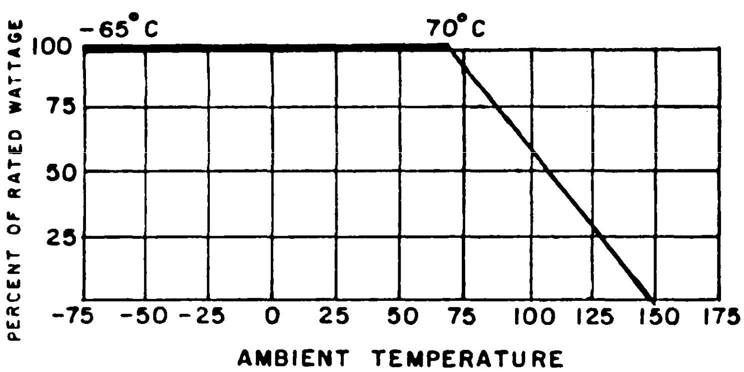
1. SCOPE

1.1 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 two, 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. alleviating static problems during shipment include elimination of loose packaging of resistors and use of metal foil and antistatic (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 ±200 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 PIN. The PIN is used for identifying and describing the resistor as shown on figuere 307-2.

3.2 Resistance values. Resistance values shall follow the decade of values as shown in the following tabulation (see table 307-I).

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in table 307-II.

TABLE 307-1. Resistance values for the 10 to 100 decade.

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 (10.0)	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 (10.0)	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	18.00	30.90	---	---	---	---	---	---	---	---
10.20	---	---	18.20	---	---	---	---	---	52.30	---	---	88.70	---	---
---	---	---	---	---	---	31.60	---	---	---	---	---	---	---	---
10.50	---	---	18.70	---	---	---	---	---	53.60	---	---	90.90	---	---
---	---	---	---	---	---	32.40	---	---	---	---	---	---	---	---
10.70	---	---	19.10	---	---	---	---	---	54.90	---	---	---	91.00	---
---	---	---	---	---	---	---	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	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	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 K 01 1A00 S M

Specification number: The number identifies the military specification number (indicating MIL-R-55342) (see table 307-II).

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

Detail number: This is the number representing the detail specification (MIL-R-55342/1).

Resistance and resistance tolerance: See table 307-I and 307-IV.

Termination: The single-letter symbol identifies termination material, type termination, and termination area as follows:

Type	Material	Termination area	Code letters
Solderable	Gold	Wraparound	G
Bondable		One surface	W
Weldable		Bonding pads	P
Solderable	Base metallization barrier metal, solder coated nickel	Wraparound	B
	Pretinned	Wraparound	R
		One surface	S
Bondable weldable	Platinum, gold	One surface	T
		Wraparound	U
Bondable	Platinum, silver	Wraparound	K
		One surface	M
	Palladium, silver	Wraparound	C
		One surface	D

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
S- - - -- 0.001 percent per/1,000 hours

FIGURE 307-2. PIN example.

TABLE 307-II. Performance characteristics.

Features	K	M	E	H
Resistance temperature characteristic, ppm/°C	100	300	25	50
Maximum ambient temperature at rated wattage	+70°C	+70°C	+70°C	+70°C
Maximum ambient temperature at zero power dc rating	+150°C	+150°C	+150°C	+150°C
Maximum operating voltage for each resistor (volts)				
M55342/1	40	40	40	40
M55342/2	40	40	40	40
M55342/3	40	40	40	40
M55342/4	40	40	40	40
M55342/5	40	40	40	40
M55342/6	50	50	50	50
M55342/7	100	100	100	100
M55342/8	150	150	150	150
M55342/9	200	200	200	200
M55342/10	40	40	40	40
Power rating (watts) at +70°C:				
M55342/1	.020	.020	.010	.010
M55342/2	.050	.050	.025	.025
M55342/3	.100	.100	.050	.050
M55342/4	.150	.150	.100	.100
M55342/5	.225	.225	.200	.200
M55342/6	.100	.100	.050	.050
M55342/7	.250	.250	.125	.125
M55342/8	.800	.800	.500	.500
M55342/9	1.000	1.000	.500	.500
M55342/10	.500	.500	.250	.250
Maximum percent change in resistance (0.01 ohm additional allowed for measurement error):				
Thermal shock 1/	.5 percent	.5 percent	.1 percent	.25 percent
Low temperature operation	.25 percent	.5 percent	.1 percent	.25 percent
Short time overload	.25 percent	.5 percent	.1 percent	.1 percent
High temperature exposure	.5 percent	1.0 percent	.1 percent	.2 percent
Resistance to bonding exposure	.25 percent	.25 percent	.2 percent	.25 percent
Moisture resistance	.5 percent	.5 percent	.2 percent	.4 percent
Life (2,000 hours)	.5 percent	2.0 percent	.5 percent	.5 percent

See footnote at end of table.

TABLE 307-II. Performance characteristics - Continued.

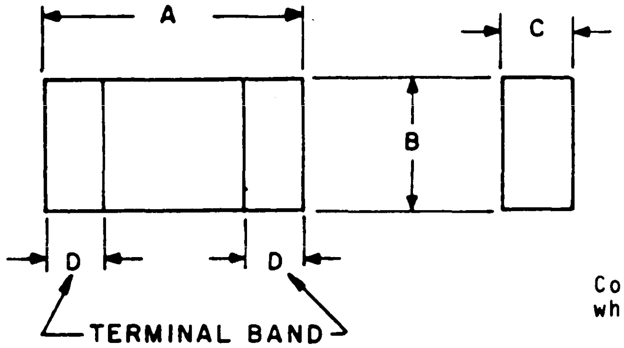
Minimum and maximum resistance values (ohms):	Min	Max
M55342/1		
Resistance tolerance B	100	.1 MΩ
Resistance tolerance F	10	.1 MΩ
Resistance tolerance G	10	.1 MΩ
Resistance tolerance J	10	.1 MΩ
Resistance tolerance K	5.6	.1 MΩ
M55342/2		
Resistance tolerance B	100	.2 MΩ
Resistance tolerance F	10	.47 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	1 MΩ
Resistance tolerance G	10	1 MΩ
Resistance tolerance J	10	1 MΩ
Resistance tolerance K	5.6	1 MΩ
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	5.6	1 MΩ
Resistance tolerance G	5.6	1 MΩ
Resistance tolerance J	5.6	1 MΩ
Resistance tolerance K	5.6	1 MΩ
M55342/7		
Resistance tolerance B	100	.500 MΩ
Resistance tolerance F	5.6	1 MΩ
Resistance tolerance G	5.6	1 MΩ
Resistance tolerance J	5.6	5.1 MΩ
Resistance tolerance K	5.6	5.6 MΩ
M55342/8		
Resistance tolerance B	100	4.99 MΩ
Resistance tolerance F	5.6	7.5 MΩ
Resistance tolerance G	5.6	15 MΩ
Resistance tolerance J	5.6	15 MΩ
Resistance tolerance K	5.6	15 MΩ

See footnote at end of table.

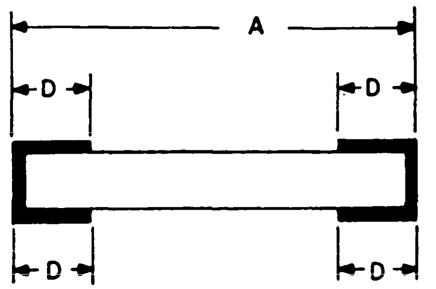
TABLE 307-II. Performance characteristics - Continued.

Minimum and maximum resistance values (ohms):	Min	Max
M55342/9		
Resistance tolerance B	100	4.99 MΩ
Resistance tolerance F	5.6	15 MΩ
Resistance tolerance G	5.6	15 MΩ
Resistance tolerance J	5.6	15 MΩ
Resistance tolerance K	5.6	15 MΩ
M55342/10		
Resistance tolerance B	5.6	5.6 MΩ
Resistance tolerance F	5.6	5.6 MΩ
Resistance tolerance G	5.6	5.6 MΩ
Resistance tolerance J	5.6	5.6 MΩ
Resistance tolerance K	5.6	5.6 MΩ

1/ Maximum ambient temperature is +150°C.



Covers termination materials S, W, D, and T.
*Also applicable to termination C, U, and R.



Covers termination materials C, U, and R which are wrap around terminations.

Termination material designation

Type	Material	Termination area	Code letters
Solderable 1/ Bondable Weldable	Gold	Wrap-around 2/ One surface Bonding pads	G W 3/ P
Solderable 1/	Base metallization barrier metal, solder coated nickel	Wrap-around 2/	B 4/
	Pretinned	Wrap-around One surface	R 5/ S 3/
Bondable weldable	Platinum, gold	One surface Wrap-around	T U
Bondable	Platinum, silver	Wrap-around 2/ One surface	K M 3/
	Palladium, silver	Wrap-around One surface	C D 3/

1/ Solderable or weldable terminations will meet the solderability test. Solderable terminations will be pretinned for solder reflow operation and will meet the solderability test.
2/ On wraparound termination, the pretinning will be, as a minimum, on at least two sides and only those surfaces must meet the solderability test. Wrap-around type will be illustrated on detail specifications.
3/ See 6.4.4.
4/ Inactive for new design.
5/ For B termination base metallization barrier metal is 50 microinches of nickel.

FIGURE 307-3. Established reliability, fixed film chip resistors.

TABLE 307-III. Available styles. 1/

Specification number	Termination	Dimension (inch) A	B	C	D	Style
MIL-R-55342/1	B,R	.050 +.025 -.005	.025 +.010 -.005	.010/.040	.016 ±.001	RM0502
	C,U	.050 +.011 -.005			.015 +.001 -.005	
	S,W,D,T	.050 2/			.010 2/	
MIL-R-55342/2	B,R	.050 +.025 -.005	.050 +.010 -.005	.010/.040	.016 ±.011	RM0505
	C,U	.050 +.011 -.005			.015 +.005 -.010	
	S,W,D,T	.050 2/			.010 2/	
MIL-R-55342/3	B,R	.100 +.025 -.005	.050 +.010 -.005	.010/.040	.021 ±.011	RM1005
	C,U	.100 +.011 -.005			.017 +.008 -.007	
	S,W,D,T	.100 2/			.015 2/	
MIL-R-55342/4	B,R	.150 +.025 -.005	.050 +.010 -.005	.010/.040	.021 ±.011	RM1505
	C,U	.150 +.011 -.005			.017 +.008 -.007	
	S,W,D,T	.150 2/			.015 2/	
MIL-R-55342/5	B,R	.225 +.025 -.005	.075 +.010 -.005	.010/.040	.022 +.013 -.012	RM2208
	C,U	.225 +.011 -.005			.020 ±.010	
	S,W,D,T	.225 2/			.015 2/	

See footnotes at end of table.

TABLE 307-III. Available styles - Continued. 1/

Specification number	Termination	Dimension (inch) A	B	C	D	Style
MIL-R-55342/6	B,R	.075 +.025 -.005	.050 +.010 -.005	.010/.040	.021 ±.011	RM0705
	C,U	.075 +.011 -.005			.017 +.008 -.007	
	S,W,D,T	.075 2/			.015 2/	
MIL-R-55342/7 (metric)	B,R	3.20 mm 2/	1.60 mm +.250 -.150	1.00 mm (max)	.350 mm 2/	RM1206 3/
	C,U	3.20 mm 2/			.350 mm 2/	
	S,W,D,T	3.45 ±.400 mm			.500 ±.250 mm	
MIL-R-55342/8	B,R	.206 2/	.098 +.010 -.006	.039 max	.013 2/	RM2010
	C,U	.206 2/			.013 2/	
	S,W,D,T	.206 ±.015			.019 ±.010	
MIL-R-55342/9	B,R	.248 2/	.124 +.010 -.006	.039 max	.013 2/	RM2512
	C,U	.248 2/			.013 2/	
	S,W,D,T	.256 ±.015			.019 ±.010	
MIL-R-55342/10	B,R	.100 ±.010	.100 2/	.020 max	.017 ±.008	RM1010
	C,U	.100 +.010			.017 ±.008	
	S,W,D,T	.100 ±.010			.017 ±.008	

1/ 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.
2/ Tolerance is ±.005 (±0.270 mm).
3/ Style RM1206 is a metric chip resistor, these dimensions are marked in millimeters.

TABLE 307-IV. Designation of resistance values for resistance all available tolerances.

Designation for .1 percent tolerance	Resistance ohms
1A00 to 9A88 inclusive	1.00 to 9.88 inclusive
10A0 to 98A8 inclusive	10.0 to 98.8 inclusive
100A to 988A inclusive	100 to 988 inclusive
1B00 to 9B88 inclusive	1,000 to 9,880 inclusive
10B0 to 98B8 inclusive	10,000 to 98,800 inclusive
100B to 988B inclusive	100,000 to 980,000 inclusive
1C00 to 9C88 inclusive	1,000,000 to 9,880,000 inclusive
10C0	10,000,000
Designation for 1 percent tolerance	**Resistance ohms**
1D00 to 9D76 inclusive	1.00 to 9.76 inclusive
10D0 to 97D6 inclusive	10.0 to 97.6 inclusive
100D to 976D inclusive	100 to 976 inclusive
1E00 to 9E76 inclusive	1,000 to 9,760 inclusive
10E0 to 97E6 inclusive	10,000 to 97,600 inclusive
100E to 976E inclusive	100,000 to 976,000 inclusive
1F00 to 9F76 inclusive	1,000,000 to 9,760,000 inclusive
10F0	10,000,000
Designation for 2 percent tolerance	**Resistance ohms**
1G00 to 90G0 inclusive	1.00 to 9.10 inclusive
10G0 to 91G0 inclusive	10.0 to 91.0 inclusive
100G to 910G inclusive	100 to 910 inclusive
1H00 to 90H0 inclusive	1,000 to 9,100 inclusive
10H0 to 91H0 inclusive	10,000 to 91,000 inclusive
100H to 910H inclusive	100,000 to 910,000 inclusive
1T00 to 9T10 inclusive	1,000,000 to 9,100,000 inclusive
10T0	10,000,000
Designation for 5 percent tolerance	**Resistance ohms**
1J00 to 9J10 inclusive	1.00 to 9.10 inclusive
10J0 to 91J0 inclusive	10.0 to 91.0 inclusive
100J to 910J inclusive	100 to 910 inclusive
1K00 to 9K10 inclusive	1,000 to 9,100 inclusive
10K0 to 91K0 inclusive	10,000 to 91,000 inclusive
100K to 910K inclusive	100,000 to 910,000 inclusive
1L00 to 9L10 inclusive	1,000,000 to 9,100,000 inclusive
10L0	10,000,000
Designation for 10 percent tolerance	**Resistance ohms**
1M00 to 8M20 inclusive	1.00 to 8.20 inclusive
10M0 to 82M0 inclusive	10.0 to 82.0 inclusive
100M to 820M inclusive	100 to 820 inclusive
1N00 to 8N20 inclusive	1,000 to 8,200 inclusive
10N0 to 82N0 inclusive	10,000 to 82,000 inclusive
100N to 820N inclusive	100,000 to 820,000 inclusive
1P00 to 8P20 inclusive	1,000,000 to 8,200,000 inclusive
10P0	10,000,000

SECTION 308

RESISTOR, FIXED, PRECISION

ESTABLISHED RELIABILITY

(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 any point 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-122 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 "catastrophic 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 characters consisting of six 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 preceding 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 308-VI.

TABLE 308-1. 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 multiplier.

RTC code 1/	Decimal point multiplier 2/	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 symbol 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		-15		+65		+125		+150		+175	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	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	RFP10
Power rating	.3 watt +125°C	.3 watt +125°C	.15 watt +125°C
Minimum resistance	10Ω	10Ω	10Ω
Maximum resistance	.200 MΩ	.200 MΩ	.400 MΩ
Maximum continuous voltage	300 V	300 V	200 V
Low temperature operation	±.01	±.01	±.01
Terminal strength	±.01	±.01	±.01
Dielectric withstanding voltage	±.01	±.01	±.01
Resistranc to soldering heat	±.01	±.01	±.01
Moisture resistance	±.02	±.01	±.01
Life	±.2	±.2	±.01
Shock	±.01	±.01	±.01
Vibration high frequency	±.01	±.01	±.01
Dielectric withstanding voltage			
Atmosphereic	300	300	500
Barometeric	200	200	200
Insulation resistance (megohms)			
Dry	10,000	10,000	10,000
Wet	100	100	100

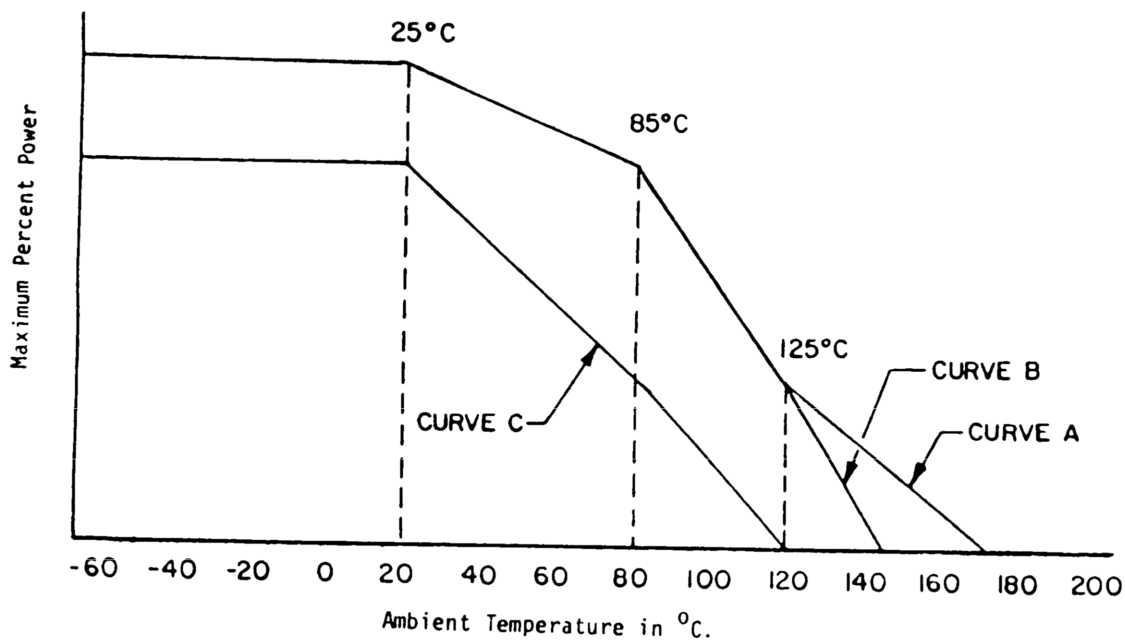
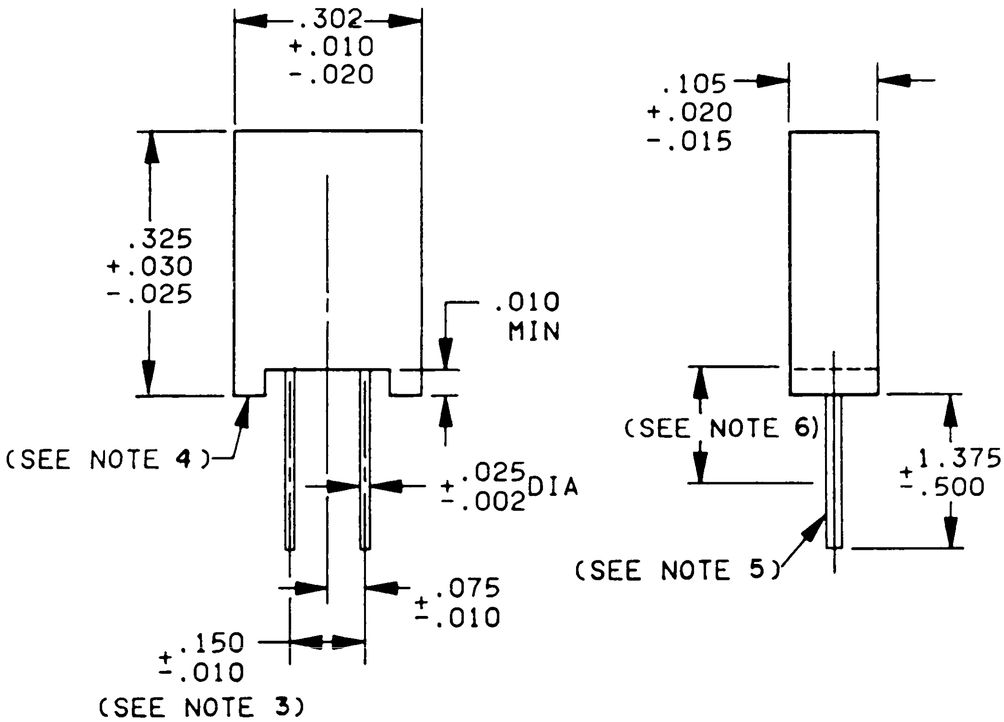


FIGURE 308-1. Power derating curve.

STYLES RPF01, RPF03, AND RPF10



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.

SECTION 400

RESISTORS, VARIABLE, ESTABLISHED RELIABILITY

SECTION 401

RESISTORS, VARIABLE, WIREWOUND (LEAD SCREW ACTUATED), ESTABLISHED RELIABILITY STYLES RTR12, RTR22, AND RTR24

(APPLICABLE SPECIFICATION: MIL-R-39015)

1. SCOPE

1.1 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 .062-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 two applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating with optimum performance.

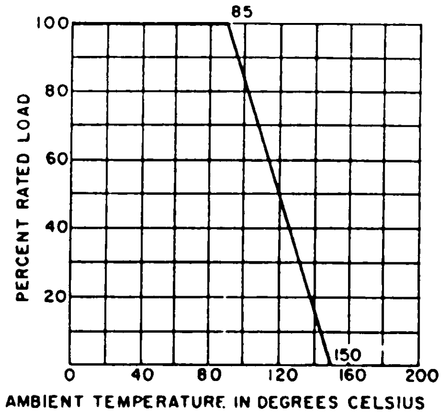


FIGURE 401-1. Derating curve for high-ambient temperature.

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.

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 nonwirewound 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 PIN. The PIN 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 on 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 hours
P - - - 0.1 percent/1,000 hours
R - - - 0.01 percent/1,000 hours

* See figure 401-4 for terminal availability for each style.

FIGURE 401-2. PIN example.

3.2 Type designation. The type designation is used for describing the resistor as shown on figure 401-3.

3.3 Performance characteristics. The performance characteristics of these resistors are as shown in table 401-I.

3.4 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

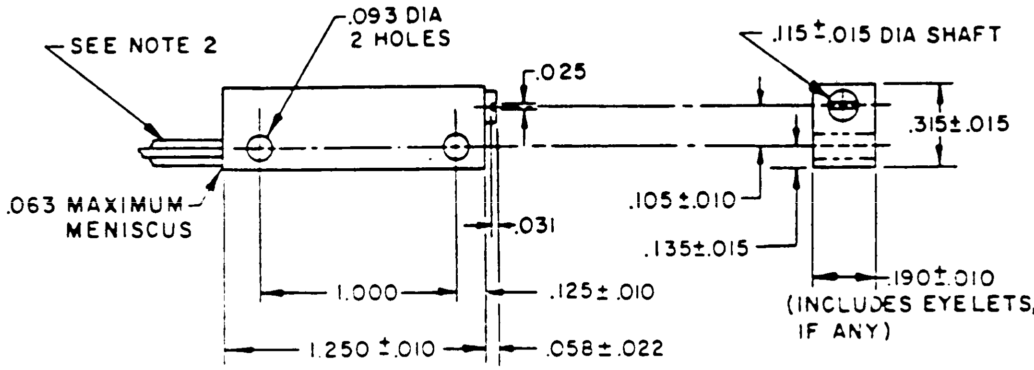
Life failure rate: The single-letter symbol identifies the life failure rate level as follows:

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

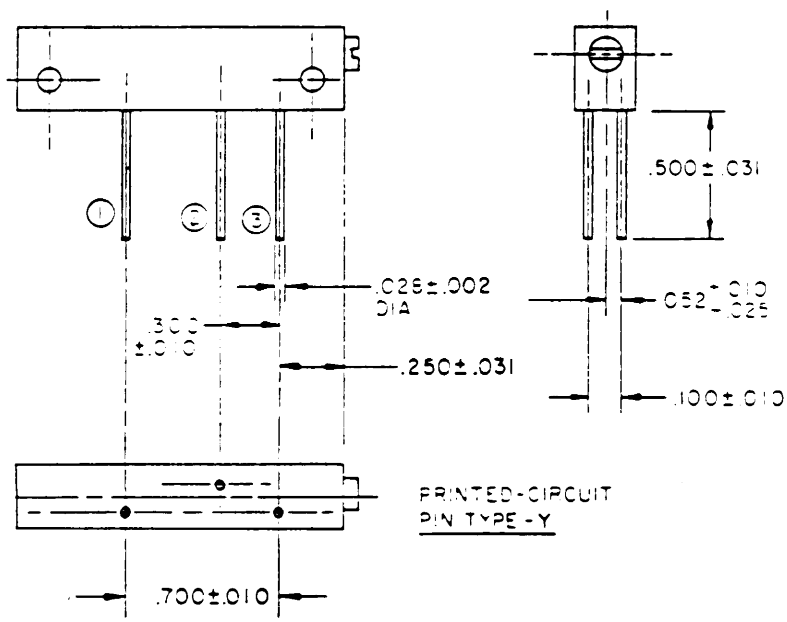
* See figure 401-4 for terminal availability for each style.

FIGURE 401-3. Type designation example.

STYLE RTR12



FLEXIBLE LEAD TERMINAL TYPE - L

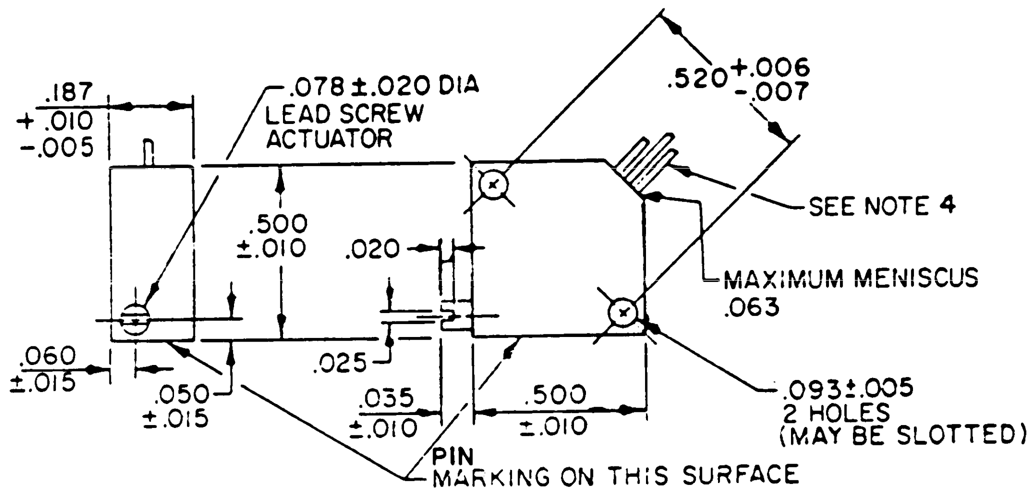


Inches	mm
.002	0.05
.010	0.25
.015	0.38
.022	0.56
.025	0.64
.028	0.71
.031	0.79
.052	1.32
.058	1.47
.063	1.60
.093	2.36
.100	2.54
.105	2.67
.115	2.92
.125	3.18
.135	3.43
.190	4.83
.250	6.35
.300	7.62
.315	8.00
.500	12.70
.700	17.78
1.000	25.40
1.250	31.75

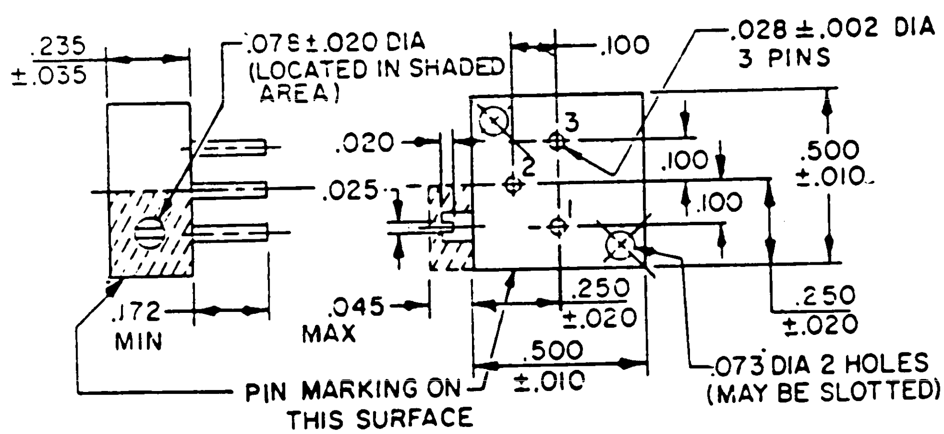
NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified. tolerance is ±.005 (0.13 mm).
4. The three leads are stranded wire, AWG size 28 to 30, 6.00 (152.40 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped approximately .250 ±.002 (6.35 ±0.05 mm) from the end, and color coded.

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors.

STYLE RTR22



TERMINAL TYPE L

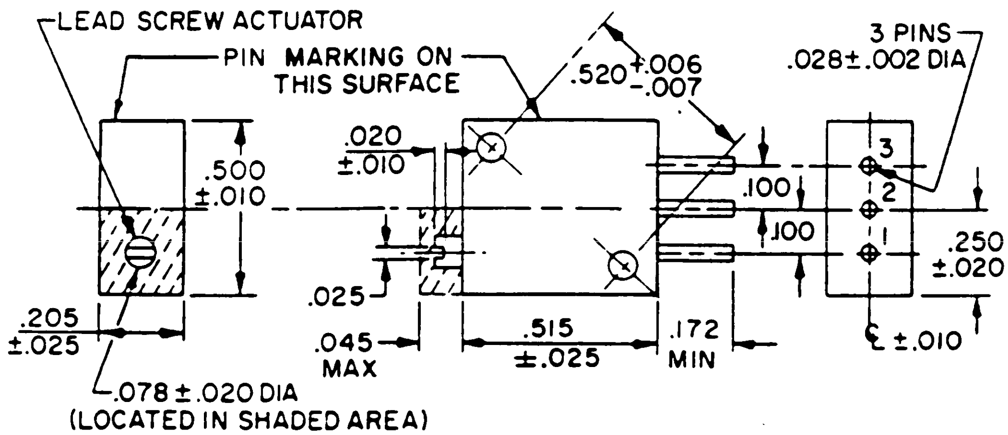


TERMINAL TYPE P

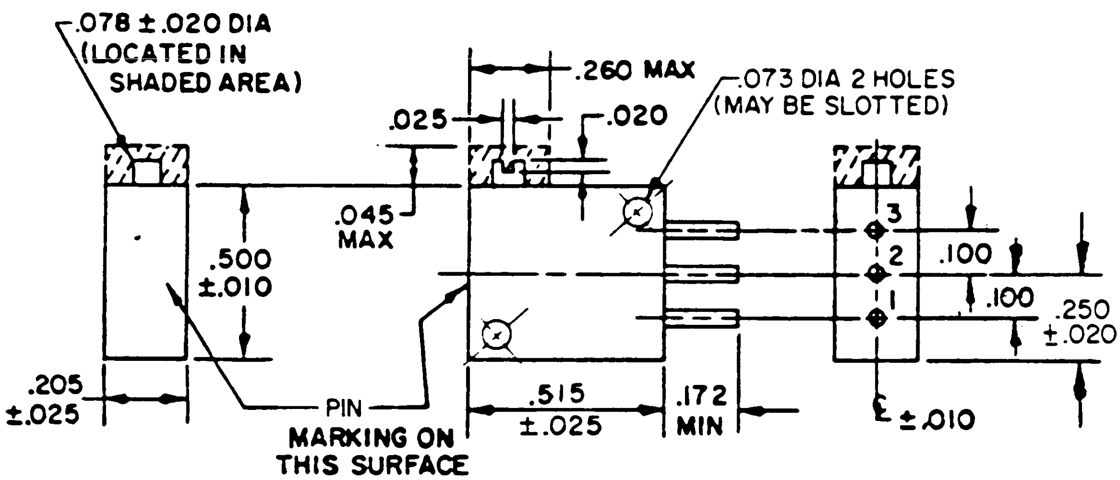
Inches	mm	Inches	mm	Inches	mm
.002	0.05	.028	0.71	.172	4.37
.003	0.08	.035	0.89	.187	4.75
.005	0.13	.045	1.14	.205	5.21
.006	0.15	.050	1.27	.235	5.97
.007	0.18	.060	1.52	.250	6.35
.010	0.25	.073	1.85	.260	6.60
.015	0.38	.078	1.98	.500	12.70
.020	0.51	.093	2.36	.515	13.08
.025	0.64	.100	2.54	.520	13.21

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

STYLE RTR22



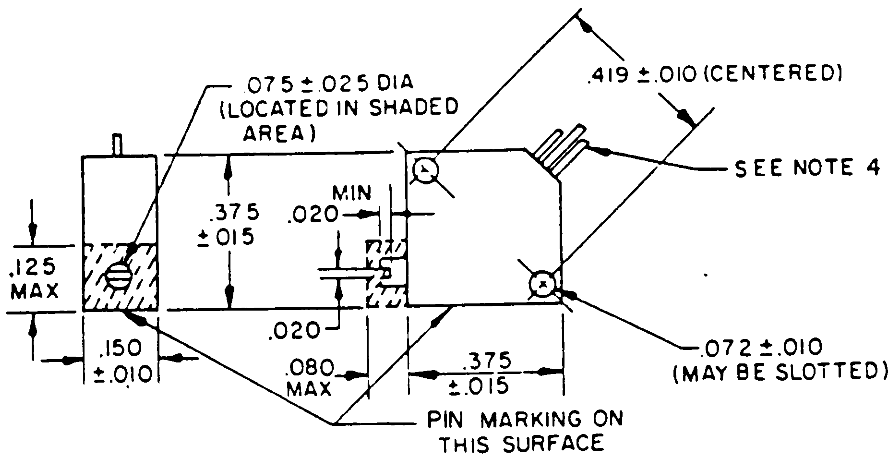
TERMINAL TYPE W



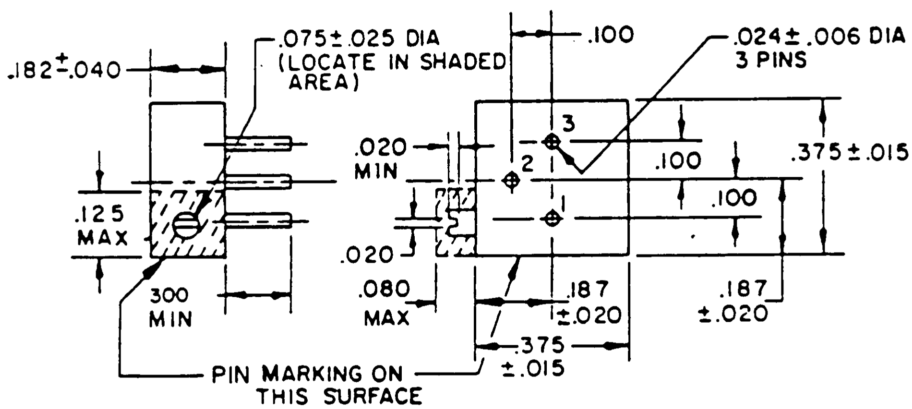
NOTES:
1. Unless otherwise specified, tolerance is ±.005 (0.13 mm).
2. The entire slot of the actuating screw is above the surface of the unit.
3. For types P, W, and X, normal mounting means is by use of pins only.
4. The three leads are stranded wire, AWG size 28 to 30, 6.00 (152.40 mm) minimum length; 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

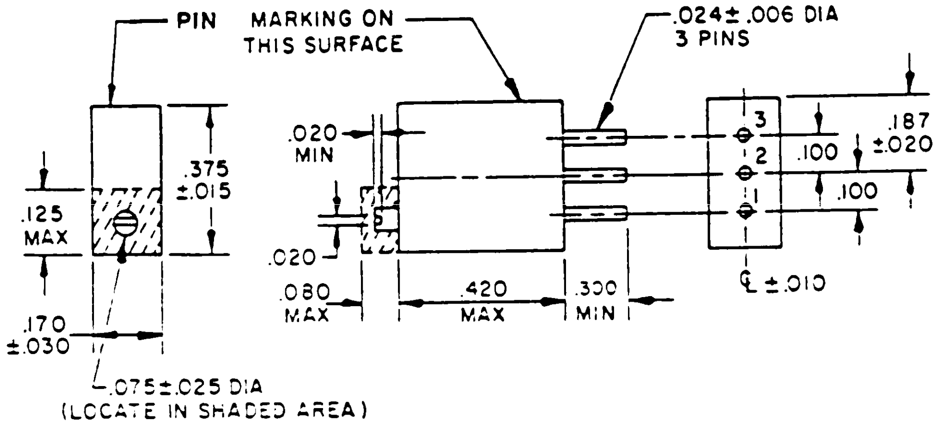


TERMINAL TYPE P

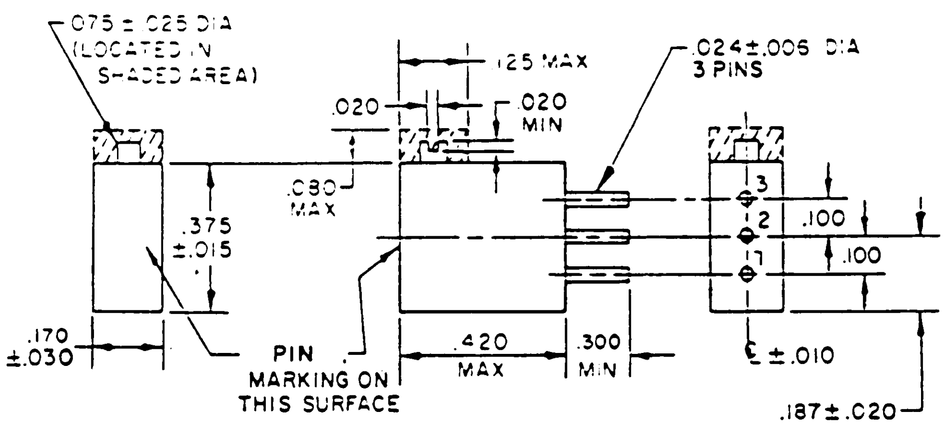
Inches	mm	Inches	mm	Inches	mm
.006	0.15	.038	0.97	.170	4.32
.009	0.23	.040	1.02	.182	4.62
.010	0.25	.072	1.83	.184	4.67
.015	0.38	.075	1.91	.187	4.75
.020	0.51	.080	2.03	.300	7.62
.024	0.61	.100	2.54	.375	9.53
.025	0.64	.125	3.18	.419	10.64
.035	0.75	.150	3.81	.420	10.67

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

STYLE RTR24



TERMINAL TYPE W



TERMINAL TYPE X

Inches	mm
.006	0.15
.010	0.25
.015	0.38
.020	0.51
.024	0.61
.025	0.64
.030	0.76
.075	1.91
.080	2.03
.100	2.54
.125	3.18
.170	4.32
.187	4.75
.375	9.53
.420	10.67

NOTES:
1. Dimensions are in inches.
2. Metrics are given for general information only.
3. Unless otherwise specified tolerance is ±.005 (0.13 mm).
4. The entire slot of-the actuating screw is above the surface of the unit.
5. 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.
6. The three leads are stranded wire, AWG size 28 to 30, 6.00 (152.40 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped .250 ±.062 (6.35 ±1.57 mm) from the end, and color coded.
7. Maximum weight is 1.3 grams.

FIGURE 401-4. Established reliability, lead screw actuated, wirewound, variable resistors - Continued.

Nominal resistance value 3/	Maximum rated ac and dc working voltage	PIN 1/ 2/			Type designation (for information only) 2/		
		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 4/	61.3	006--	006--	009--	502-	502-	502-
10,000 5/	86.7	007--	007--	---	103-	103-	---

1/ 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.

2/ Complete PIN (and type designation) includes additional symbols to indicate terminal type and failure rate level (see figures 401-2 and 401-3).

3/ 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.

4/ For style RTR24, value based on use of wire having no less than 0.001-inch ±10 percent diameter.

5/ For RTR12 and RTR22, value based on the use of wire having no less than 0.001-inch nominal (0.0009 absolute) diameter.

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)	.750	.750	.750
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-hours cont. to 10,000)	2.0	2.0	2.0
Failure rate determination (10,000 hours)	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, NONWIREWOUND (ADJUSTMENT TYPE),

ESTABLISHED RELIABILITY

STYLES RJR12, RJR24, RJR26, RJR28, AND RJR50

(APPLICABLE SPECIFICATION: MIL-R-39035)

1. SCOPE

1.1 Scope. This section covers established reliability, adjustment type, nonwirewound, variable resistors with a contact which bears uniformly over the surface of a nonwirewound 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 .062-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 two applied to the wattage is recommended in order to insure the selection of a resistor style having an adequate wattage rating with optimum performance.

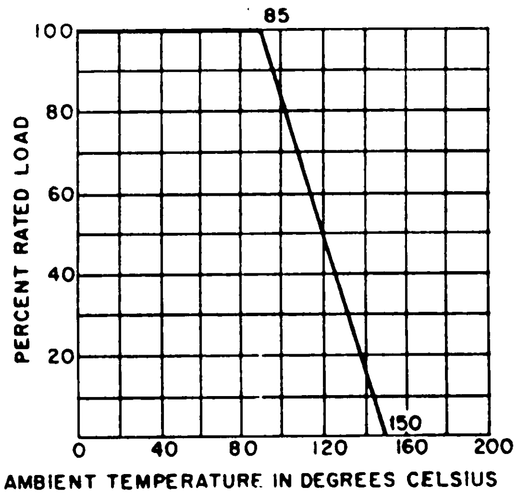


FIGURE 402-1. Derating curve for high-ambient temperature.

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.

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 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 orders.

2.7 Screening requirements. All resistors furnished under MIL-R-39035 are subjected to a 50-hour conditioning life test by cycling at .750 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
0.20	---	300	---	---	---
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, nonwire-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)
M - - - 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

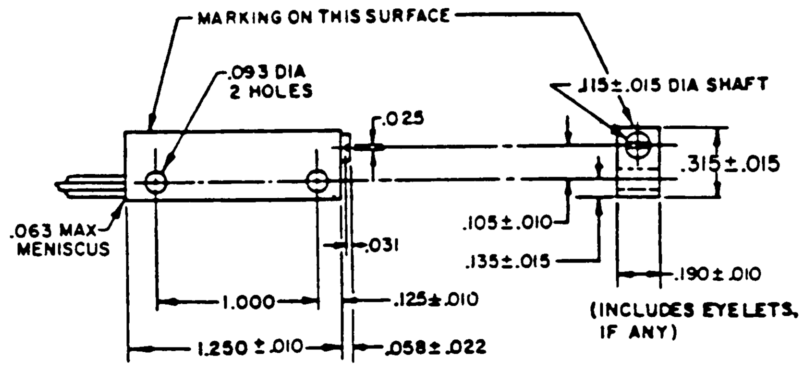
Life failure rate: The single-letter symbol identifies the life failure rate level as follows:

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

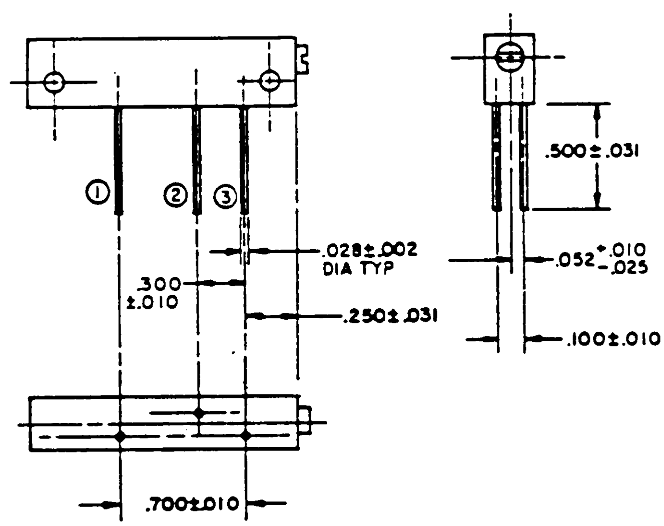
* See figure 402-3 for terminal availability for each style.

FIGURE 402-2. Type designation example.

STYLE RJR12



FLEXIBLE LEAD TERMINAL TYPE -L



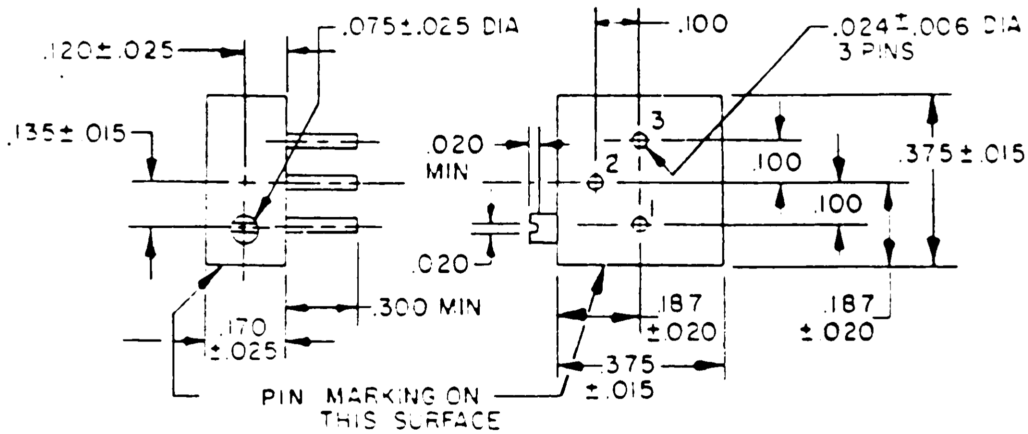
PRINTED-CIRCUIT
PIN TERMINAL TYPE -Y

Inches	mm
.002	0.05
.003	0.08
.005	0.13
.010	0.25
.015	0.38
.022	0.56
.025	0.64
.028	0.71
.031	0.79
.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

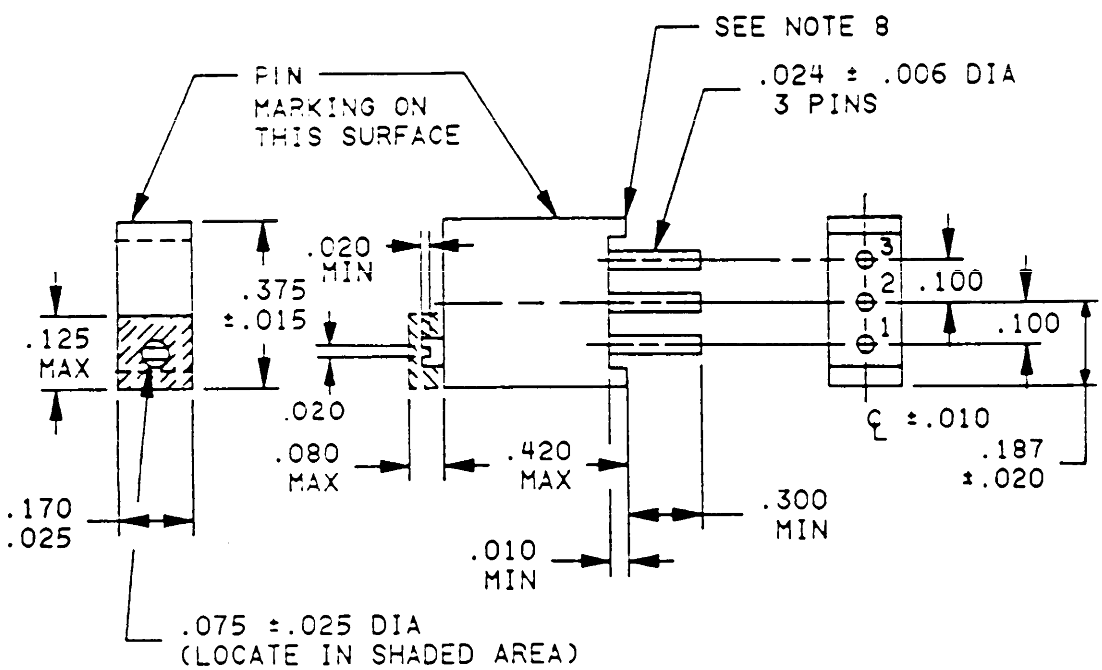
NOTES:
1. Unless otherwise specified, tolerance is +.005 (0.13 mm).
2. The three leads are of stranded wire, AWG size 28 to 30, 6.00 (152.40 mm) minimum length; they are insulated with polytetrafluoroethylene, stripped .250 +.062 (6.35 +1.57 mm) from the end, and color coded.
3. The picturization of 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, nonwirewound, variable resistors.

STYLE RJR24



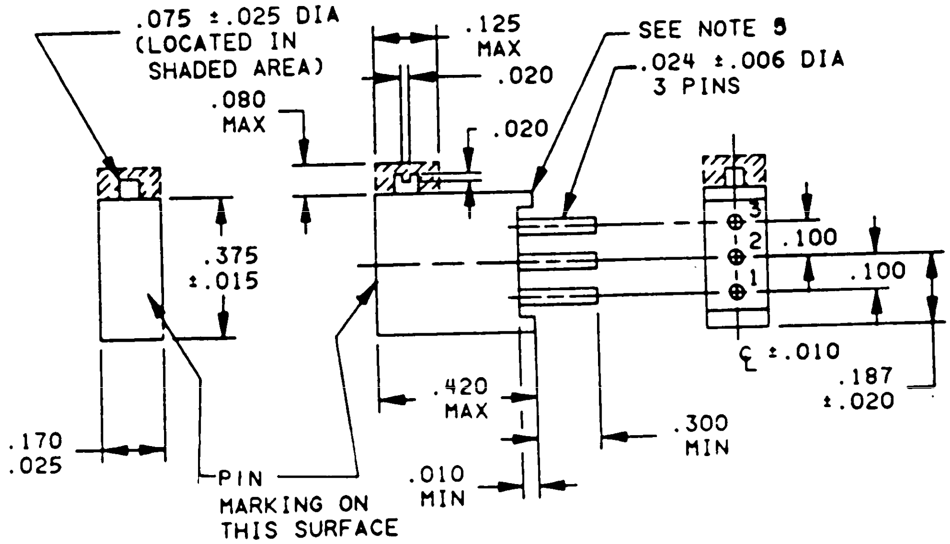
TERMINAL TYPE P



TERMINAL TYPE W

FIGURE 402-3. Established reliability, adjustment type, nonwirewound, variable resistors - Continued.

STYLE RJR24



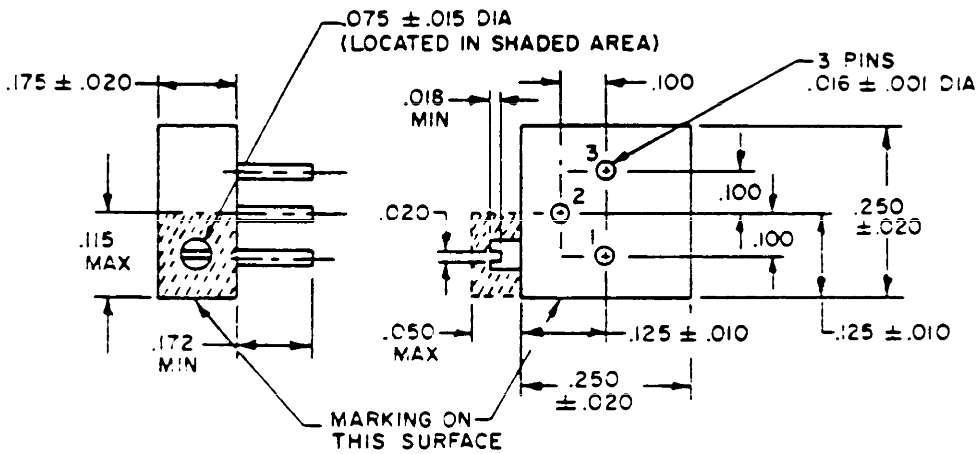
TERMINAL TYPE X

Inches	mm	Inches	mm
.002	0.05	.105	2.67
.006	0.15	.120	3.05
.010	0.25	.125	3.18
.015	0.38	.135	3.43
.020	0.51	.170	4.32
.024	0.61	.172	4.37
.025	0.64	.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 (0.13 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 (152.40 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.

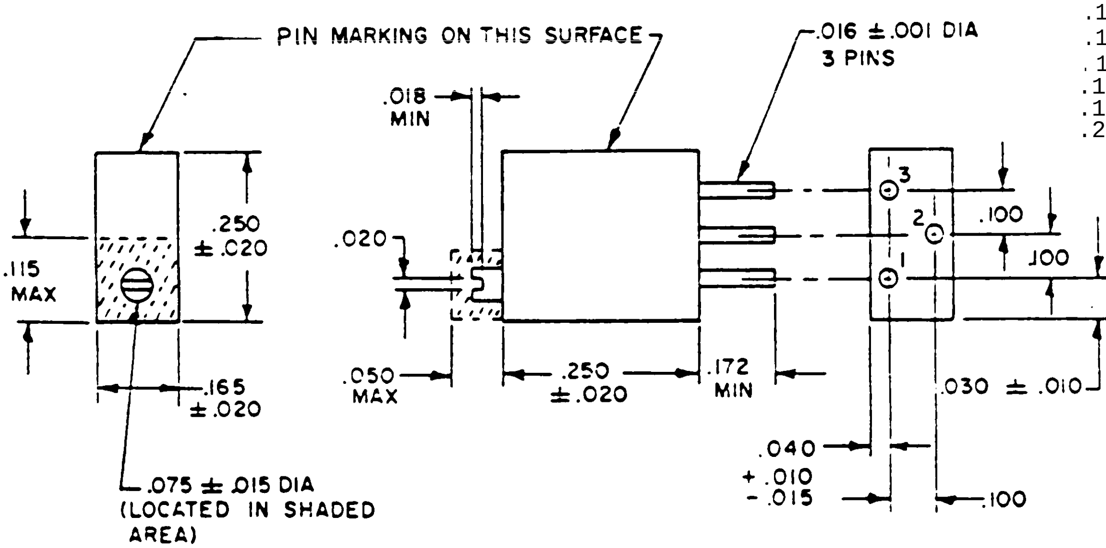
FIGURE 402-3. Established reliability, adjustment type, nonwirewound, variable resistors - Continued.

STYLE RJR26



TERMINAL TYPE P

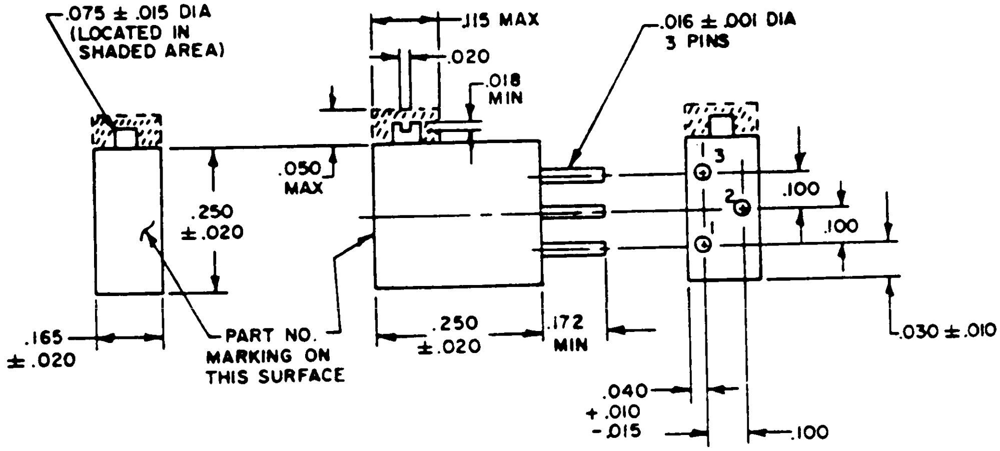
Inches	mm
.001	0.02
.010	0.25
.015	0.38
.016	0.40
.018	0.45
.020	0.50
.030	0.76
.040	1.01
.050	1.27
.075	1,90
.100	2.54
.115	2.92
.125	3.17
.165	4.19
.172	4.36
.175	4.44
.250	6.35



TERMINAL TYPE W

FIGURE 402-3. Established reliability, adjustment type, nonwirewound, variable resistors - Continued.

STYLE RJR26



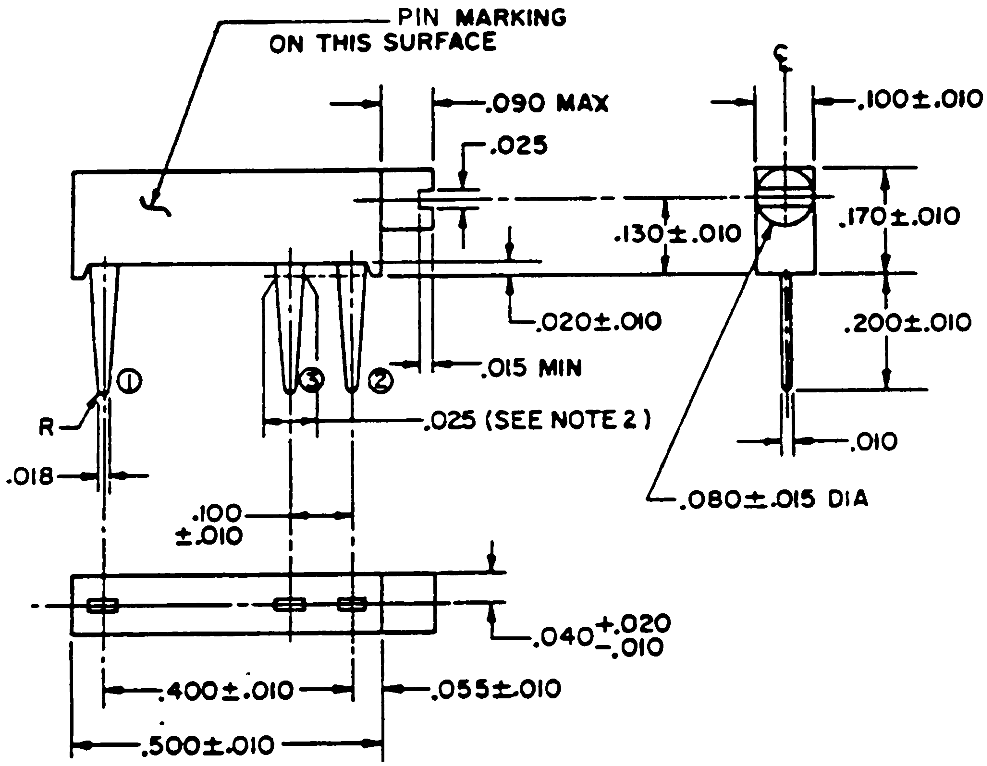
TERMINAL TYPE X

Inches	mm
.001	0.03
.010	0.25
.015	0.38
.016	0.41
.018	0.46
.020	0.51
.030	0.76
.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 is 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, nonwirewound, variable resistors - Continued.

STYLE RJR28



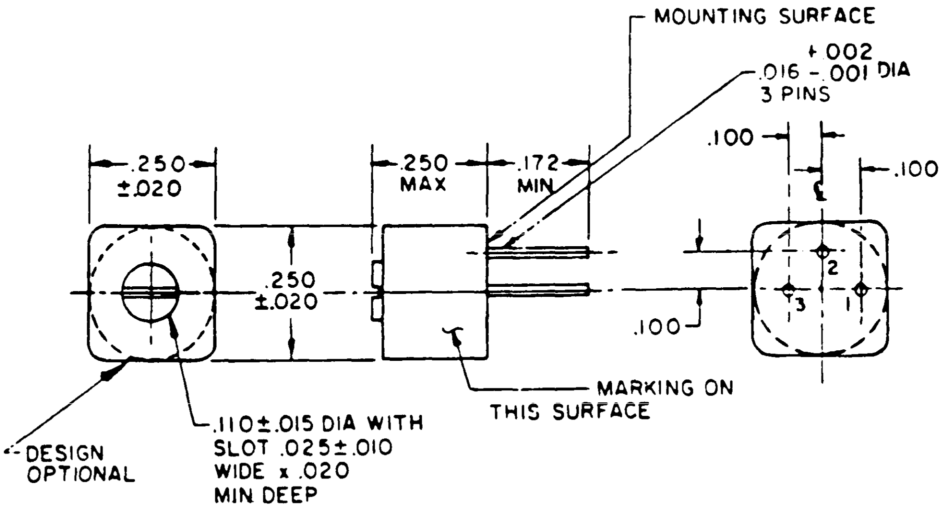
TERMINAL TYPE P

Inches	mm	Inches	mm
.010	0.25	.090	2.29
.015	0.38	.100	2.54
.018	0.46	.130	3.30
.020	0.51	.170	4.32
.025	0.64	.200	5.08
.040	1.02	.400	10.16
.055	1.40	.500	12.70

NOTES:
1. Unless otherwise specified, tolerance is ±.005 (0.13 mm).
2. Terminal width is .025 (0.64 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, nonwirewound, varlable resistores - Continued.

STYLE RJR50



TERMINAL TYPE P

Inches	mm
.001	0.03
.002	0.05
.010	0.25
.015	0.38
.016	0.41
.020	0.51
.025	0.64
.100	2.54
.110	2.79
.172	4.37
.250	6.35

NOTES:
1. Unless otherwise specified, tolerance is ±.005 (0.13 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 styles above are given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.

FIGURE 402-3. Established reliability, adjustment type, nonwirewound, 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)	.750	.500	.250	0.300	.250
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 hours cont. to 10,000)	3.0	3.0	3.0	3.0	3.0
Failure rate determination (10,000 hours)	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 402-1. 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 501A

RESISTOR NETWORKS, FIXED, FILM

STYLES RZO1O, RZ020, RZ030, RZ040, RZ050, RZ060, RZ070, RZ080, AND RZ090

(Applicable SPECIFICATION: MIL-R-83401)

1. SCOPE

1.1 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.

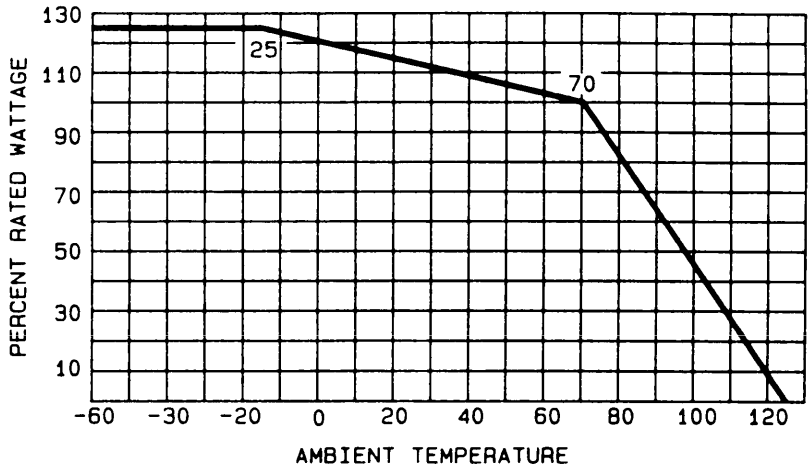
2.1.1 Construction. In these resistors the resistance element consists of a film element on a ceramic substrate. The element is formed either by deposition of a vaporized metal or the printing of a metal and glass combination paste which has then been fired at a high temperature. Resistance elements 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-I.

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 two 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.



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.

2.4 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.

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 furnished 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 PIN designation. The PIN designation is used for identifying and describing the resistor as shown on figure 501-2.

3.2 Resistance values. Resistance values shall follow the decade of values as shown in the following tabulation (see table 501-I).

3.3 Performance characteristics. Performance characteristics are shown in table 501-II.

TABLE 501-I. Resistance values for the 10 to 100 decade.

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	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	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	A010	330	470
A002	120	200	A011	330	680
A003	130	210	A012	1.5 k	3.3 k
A004	160	260	A013	3.0 k	6.2 k
A005	180	240	A014	180	270
A006	180	390	A015	270	270
A007	220	270	A016	560	560
A008	220	330	A017	560	1.2 k
A009	330	390	A018	620	2.7 k

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	A010	330	470
A002	120	200	A011	330	680
A003	130	210	A012	1.5 k	3.3 k
A004	160	260	A013	3.0 k	6.2 k
A005	180	240	A014	180	270
A006	180	390	A015	270	270
A007	220	270	A016	560	560
A008	220	330	A017	560	1.2 k
A009	330	390	A018	620	2.7 k

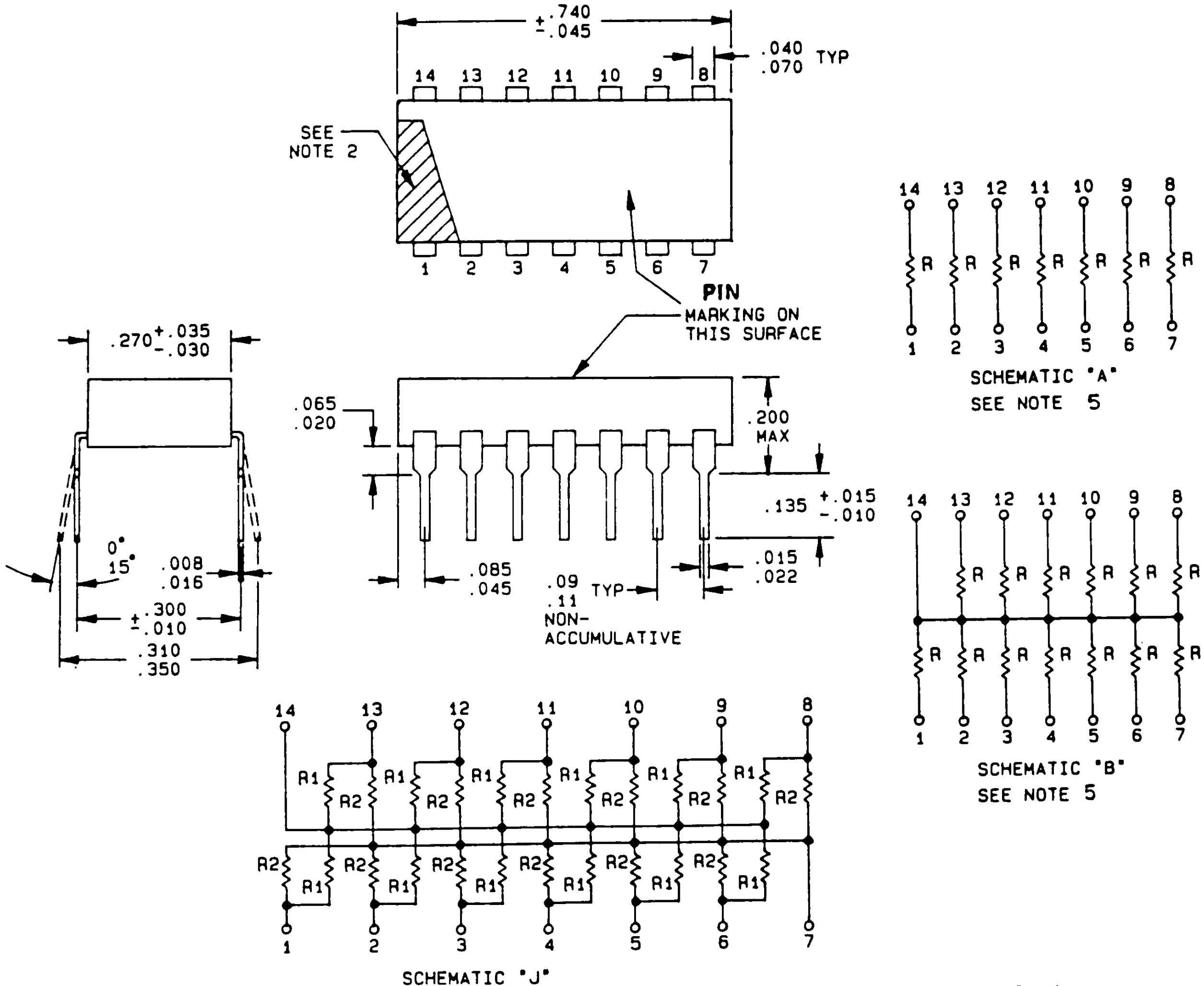
Resistance tolerance: The single-letter symbol identifies the resistance tolerance as follows:

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. PIN example:

STYLE RZ010

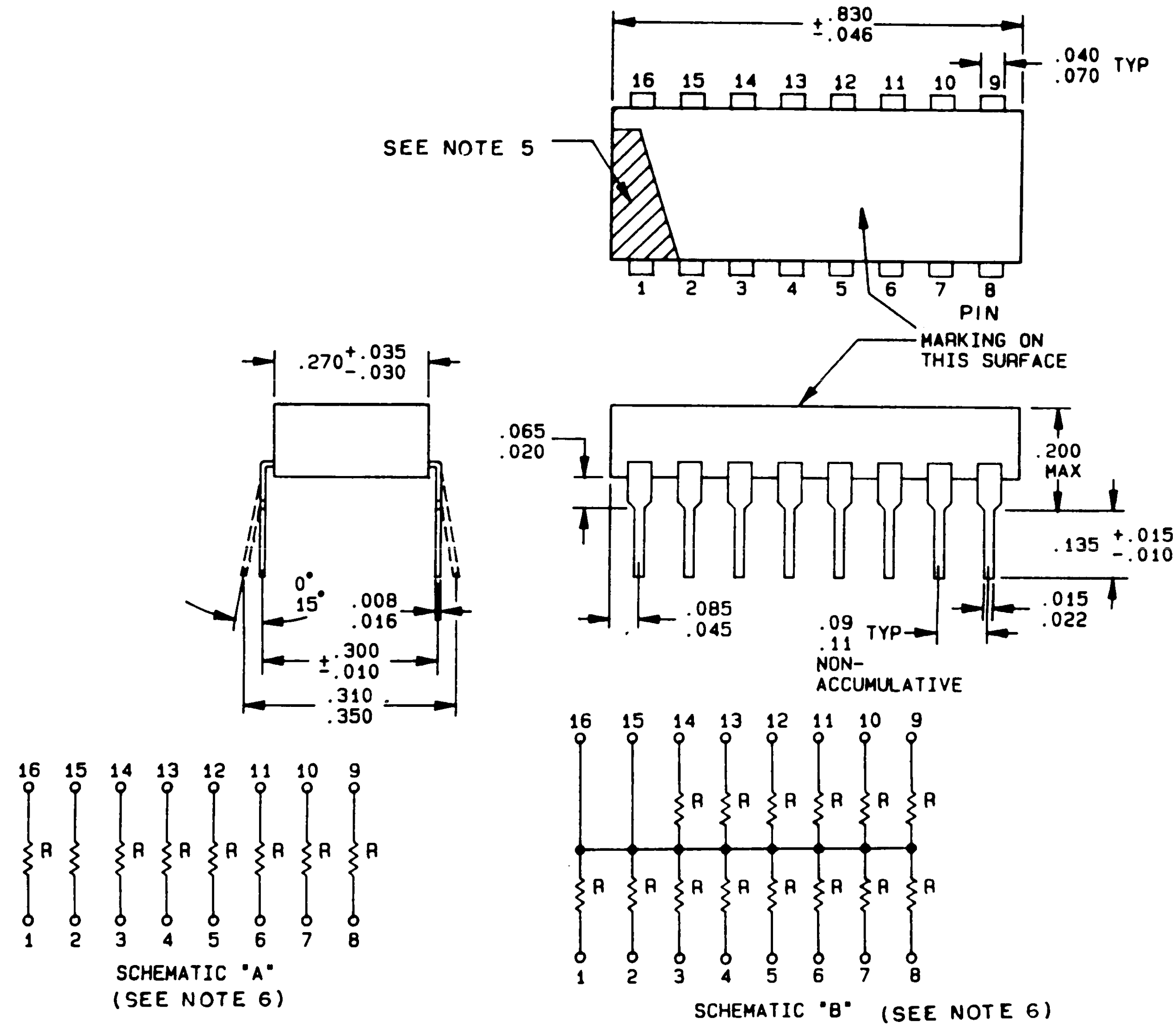


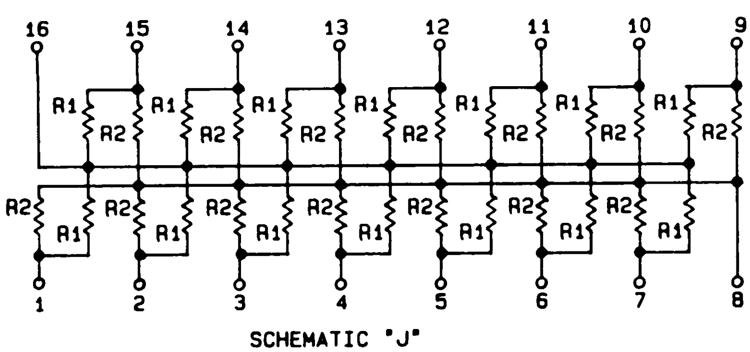
Inches	mm	Inches	mm	Inches	mm
.008	0.20	.040	1.02	.200	5.08
.010	0.25	.045	1.14	.270	6.86
.015	0.38	.065	1.65	.300	7.62
.016	0.41	.070	1.78	.310	7.87
.020	0.51	.085	2.16	.350	8.89
.022	0.56	.090	2.29	.740	18.80
.030	0.76	.110	2.79		
.035	0.89	.135	3.43		

NOTES:
1. Dimensions are in-inches.
2. Metric equivalents are given for general information only.
3. The picturization of this style is given as representative of the envelope of the item. Slight deviations from the outline shown are acceptable.
4. Pin 1 locator is a dot, stripe, notch, or numeral 1 adjacent to pin number 1 in the shaded area.
5. All resistors are equal in value.

FIGURE 501-3. Fixed film resistor networks.

STYLE RZ020





Inches	mm	Inches	mm
.008	0.20	.070	1.78
.010	0.25	.085	2.16
.015	0.38	.090	2.29
.016	0.41	.110	2.79
.020	0.51	.135	3.43
.022	0.56	.200	5.08
.030	0.76	.270	6.86
.035	0.89	.300	7.62
.040	1.02	.310	7.87
.045	1.14	.350	8.89
.046	1.17	.830	21.08
.065	1.65		

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ030

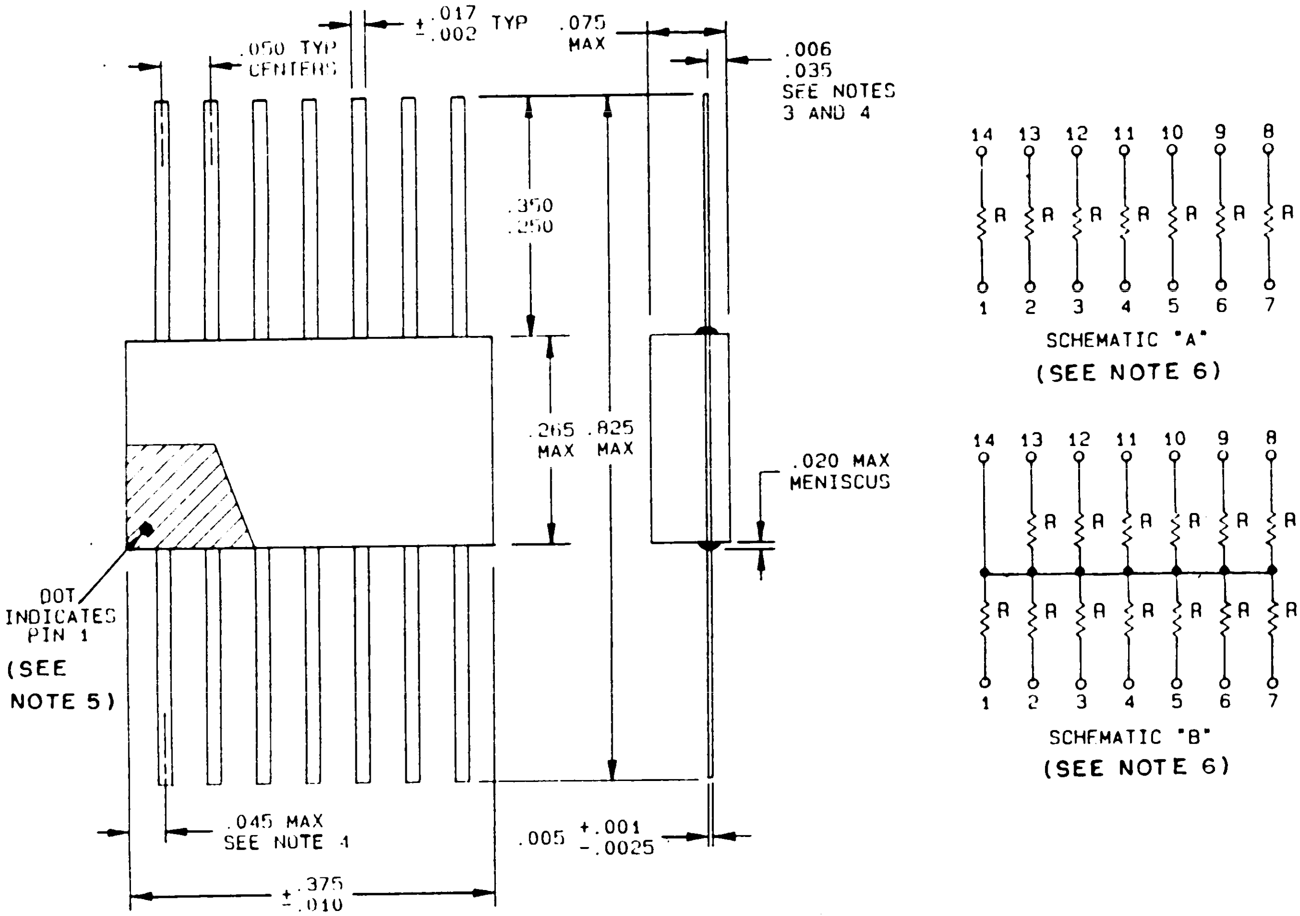
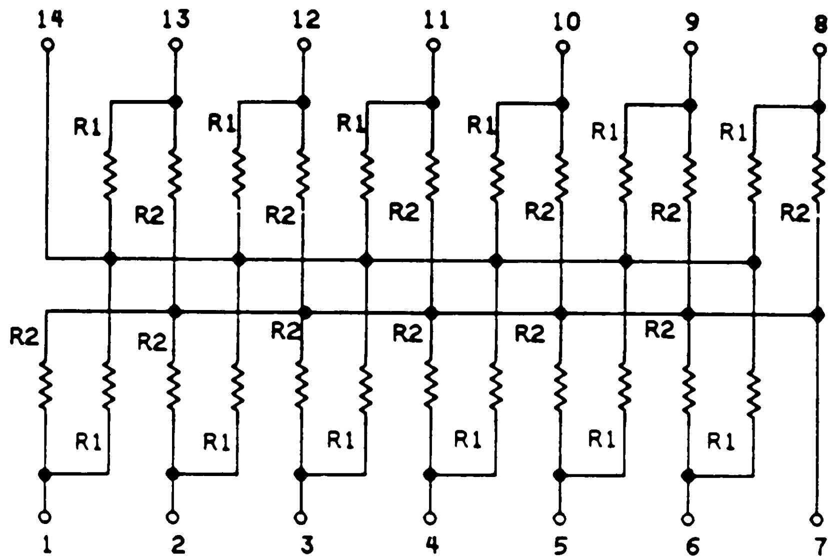


FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ030



SCHEMATIC "J"

Inches	mm	Inches	mm
.0003	0.007	.035	0.89
.001	0.03	.037	0.94
.002	0.05	.050	1.27
.0025	0.063	.065	1.65
.003	0.08	.075	1.91
.005	0.13	.025	6.35
.006	0.15	.265	6.73
.010	0.25	.35	8.9
.017	0.43	.375	9.53
.020	0.51	.825	20.96

NOTES:
1. Unless otherwise specified, tolerances are ±.005 (0.13 mm).
2. 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.
3. Terminal centerline to centerline measurements made at point of emergence of the lead from the body.
4. Measurement made at point of emergence of the lead from the body, measured at all 4 corner leads.
5. Pin 1 locator is a dot, notch, stripe, or numeral 1 adjacent to pin number 1, in the shaded area.
6. All resistors are equal in value.

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ040

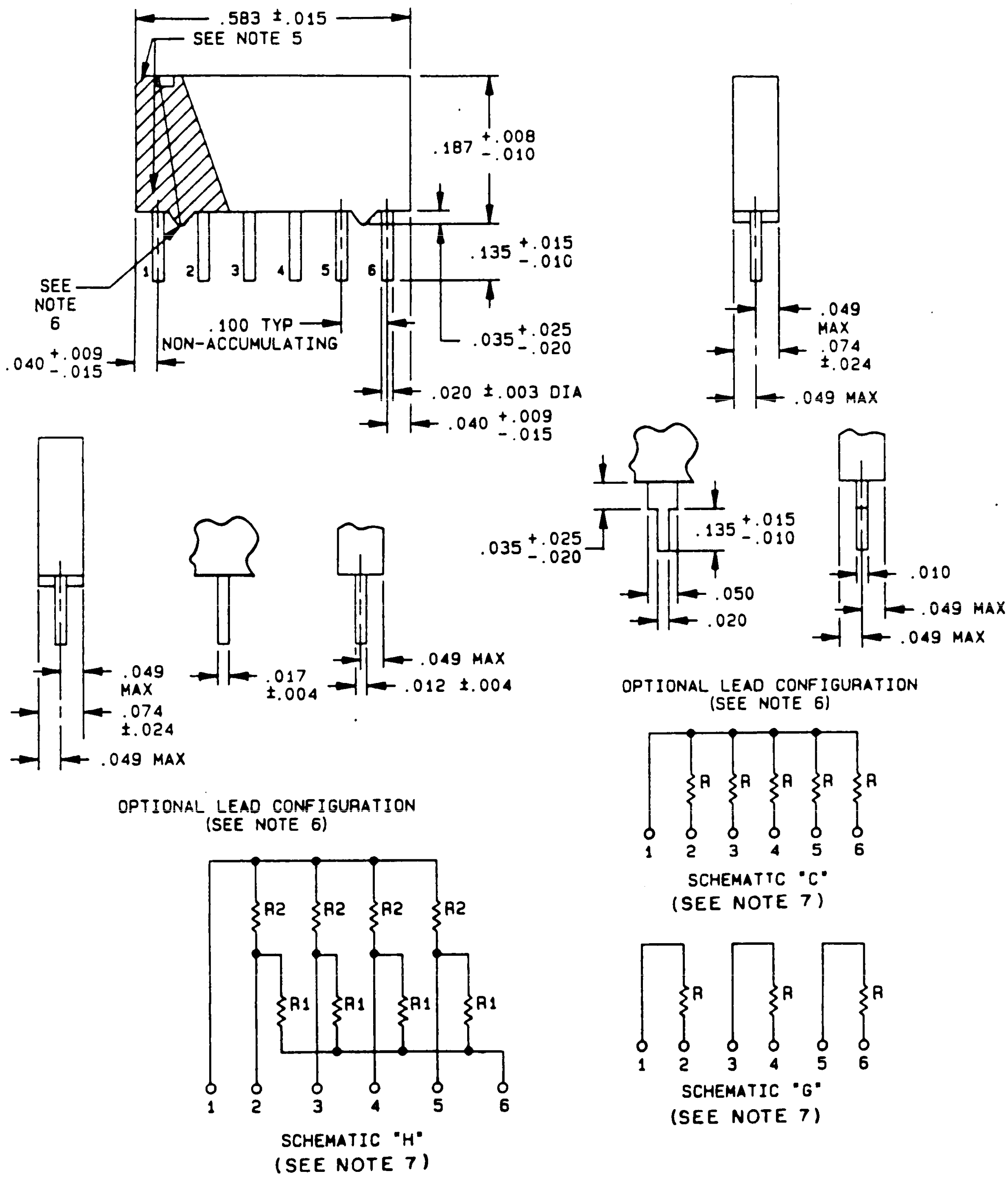
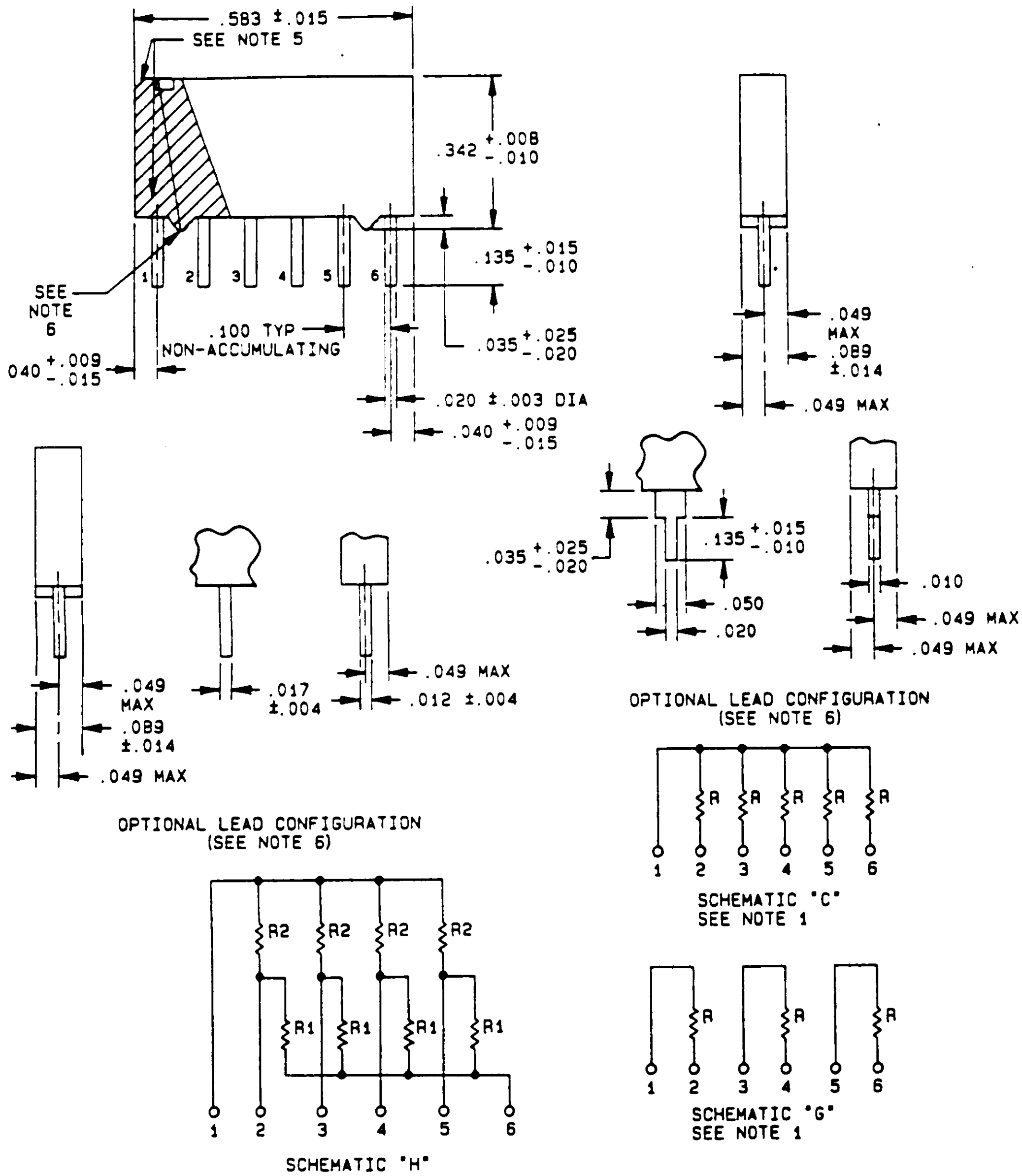


FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ040



Inches	mm
.003	0.08
.005	0.13
.008	0.20
.009	0.23
.010	0.25
.012	0.30
.013	0.33
.014	0.36
.015	0.38
.017	0.43
.020	0.51
.030	0.76
.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

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ050

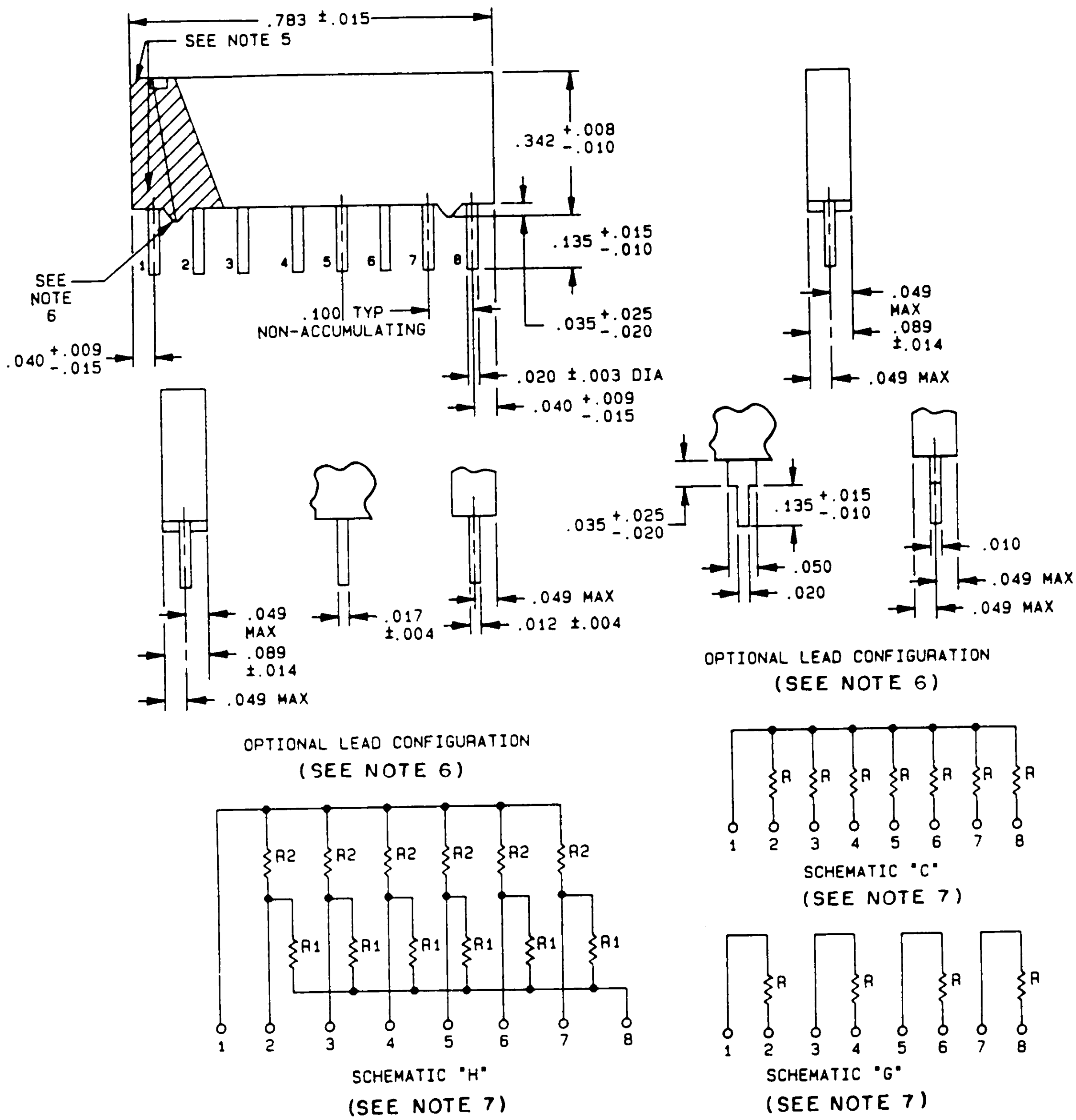
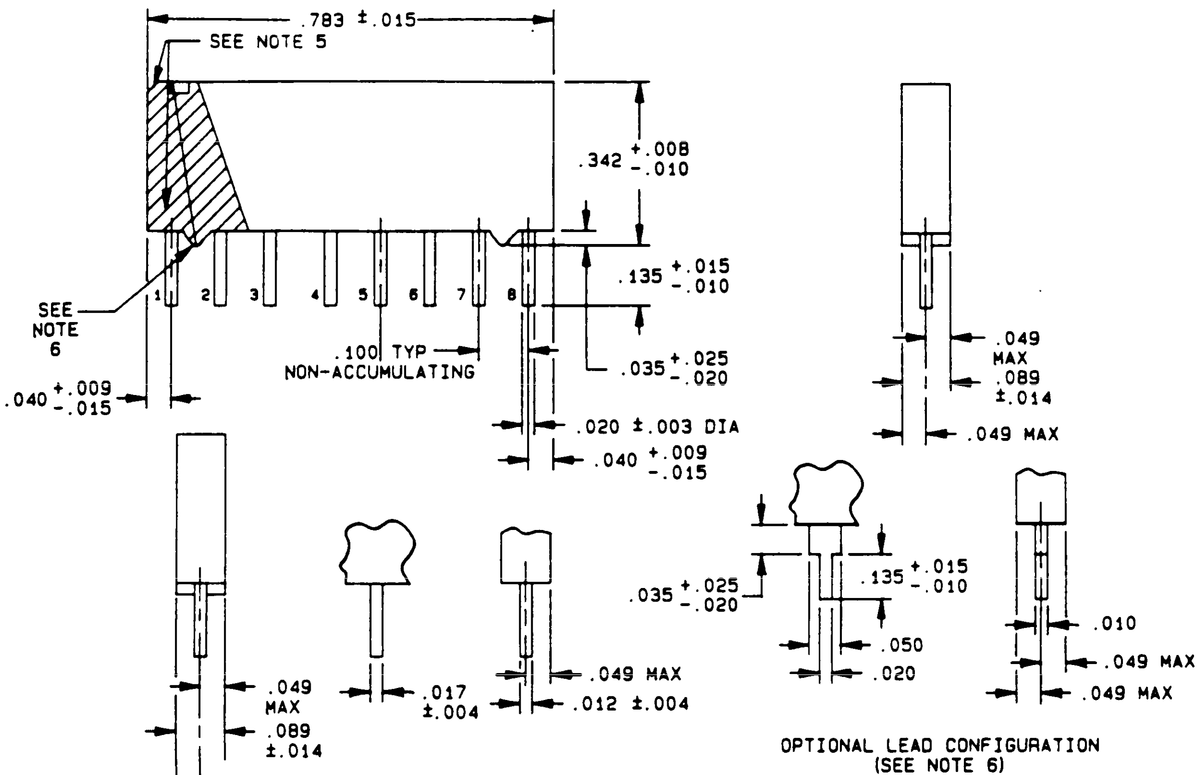
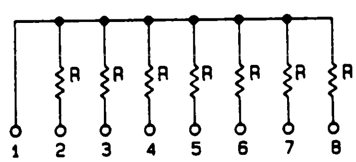
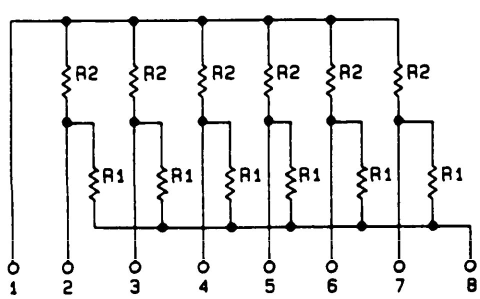


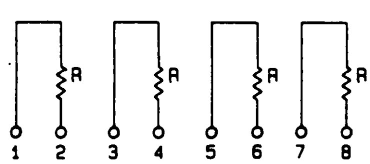
FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ050









Inches	mm	Inches	mm
.003	0.08	.030	0.76
.004	0.10	.040	1.02
.005	0.13	.041	1.04
.008	0.20	.049	1.24
.009	0.23	.050	1.27
.010	0.25	.082	2.08
.012	0.30	.089	2.26
.013	0.33	.100	2.54
.015	0.38	.135	3.43
.017	0.43	.342	8.69
.020	0.51	.783	19.89

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ060

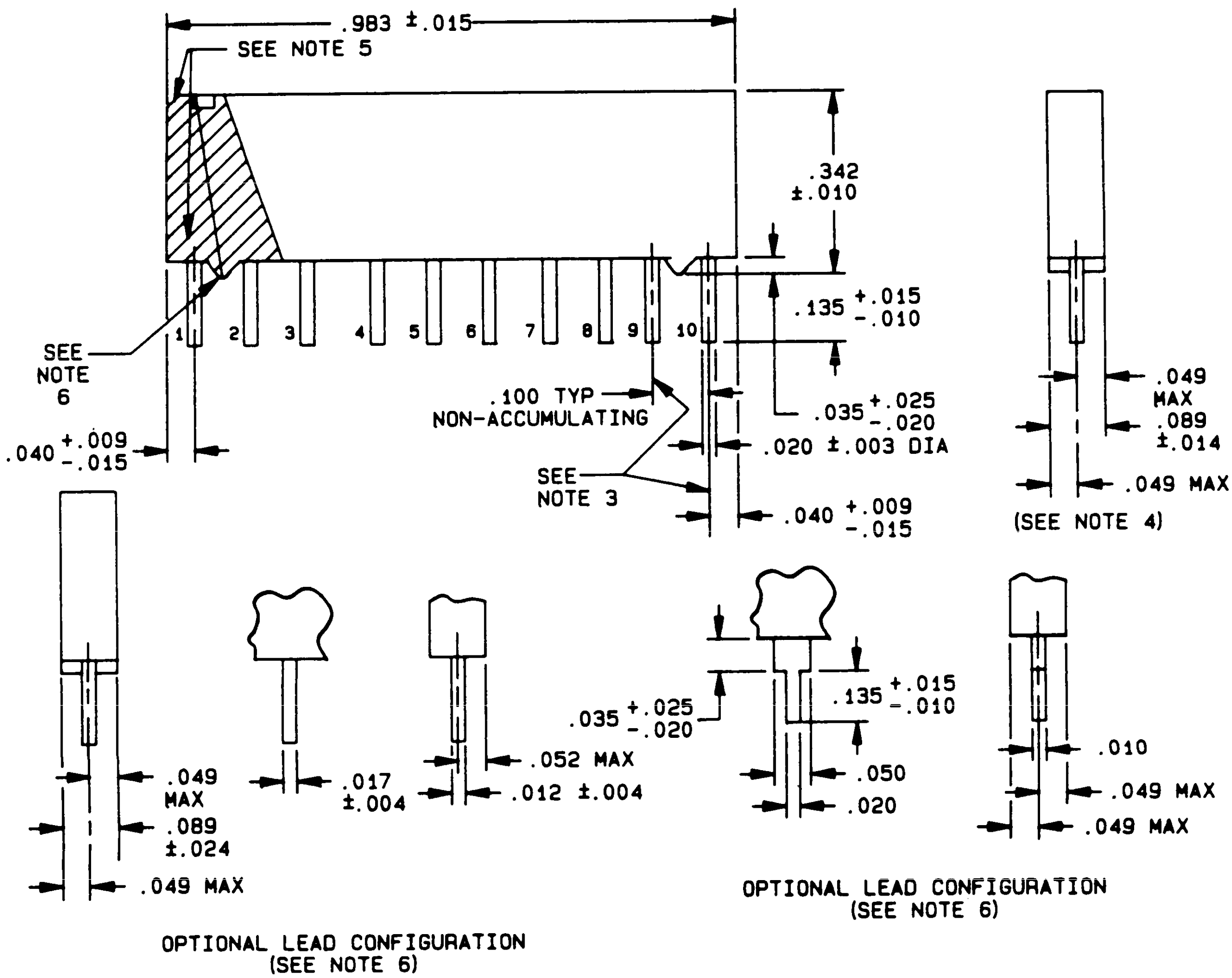
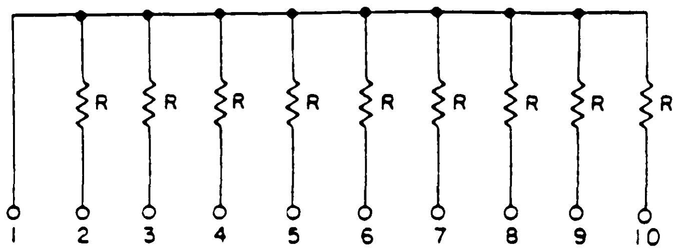
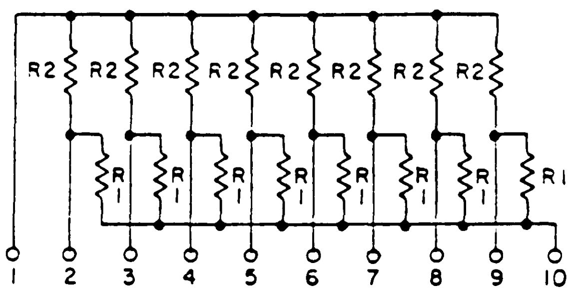


FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ060

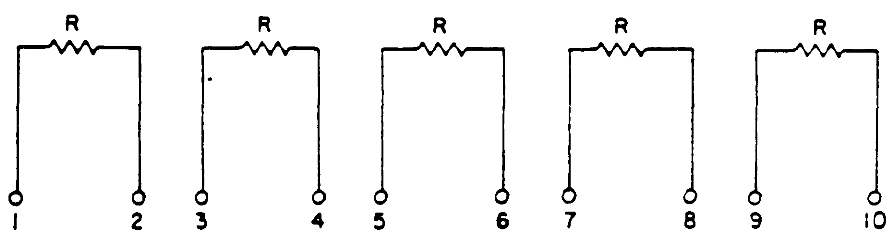


SCHEMATIC C



SCHEMATIC H

Inches	mm	Inches	mm
.003	0.08	.030	0.76
.004	0.10	.040	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

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ070

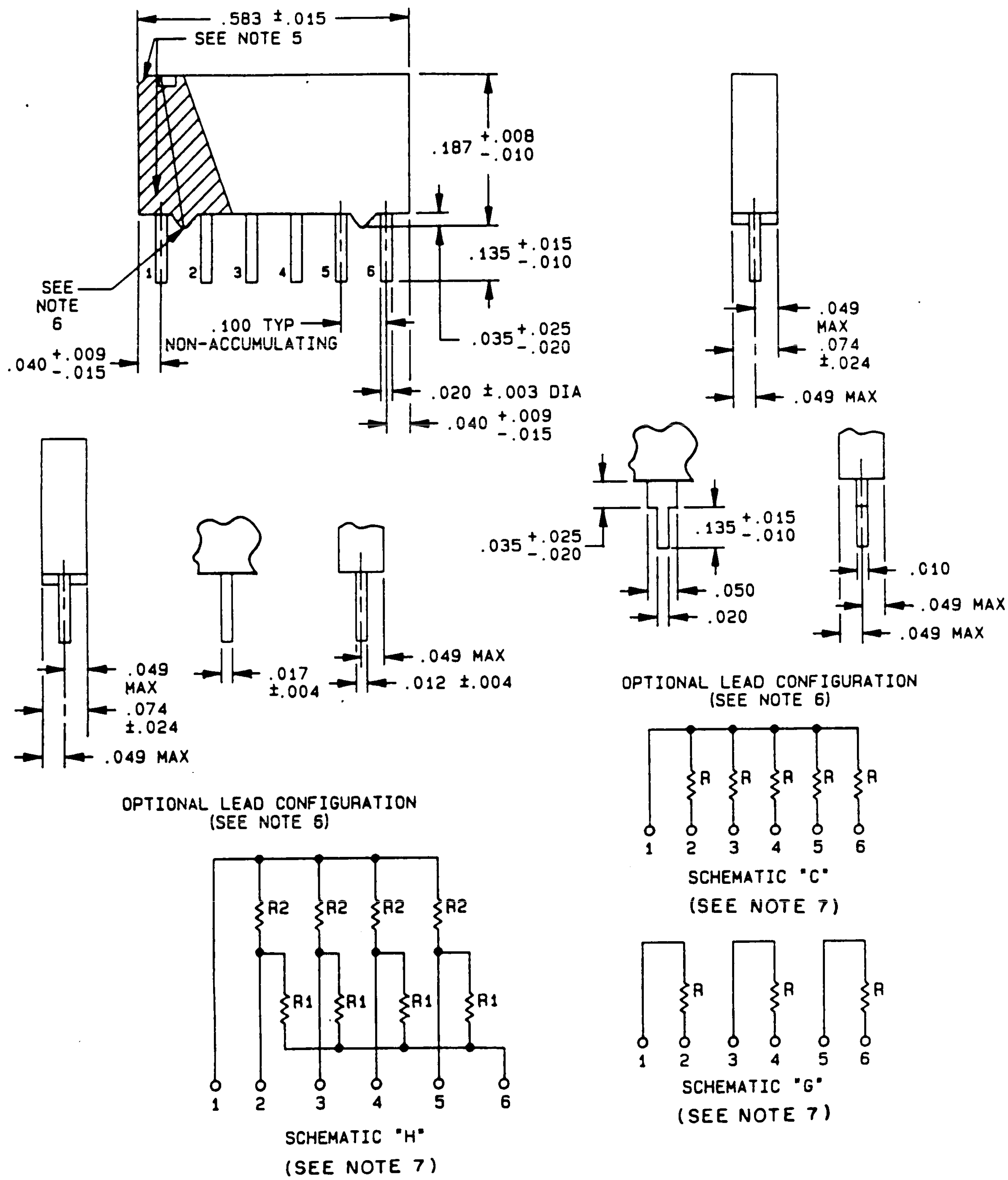
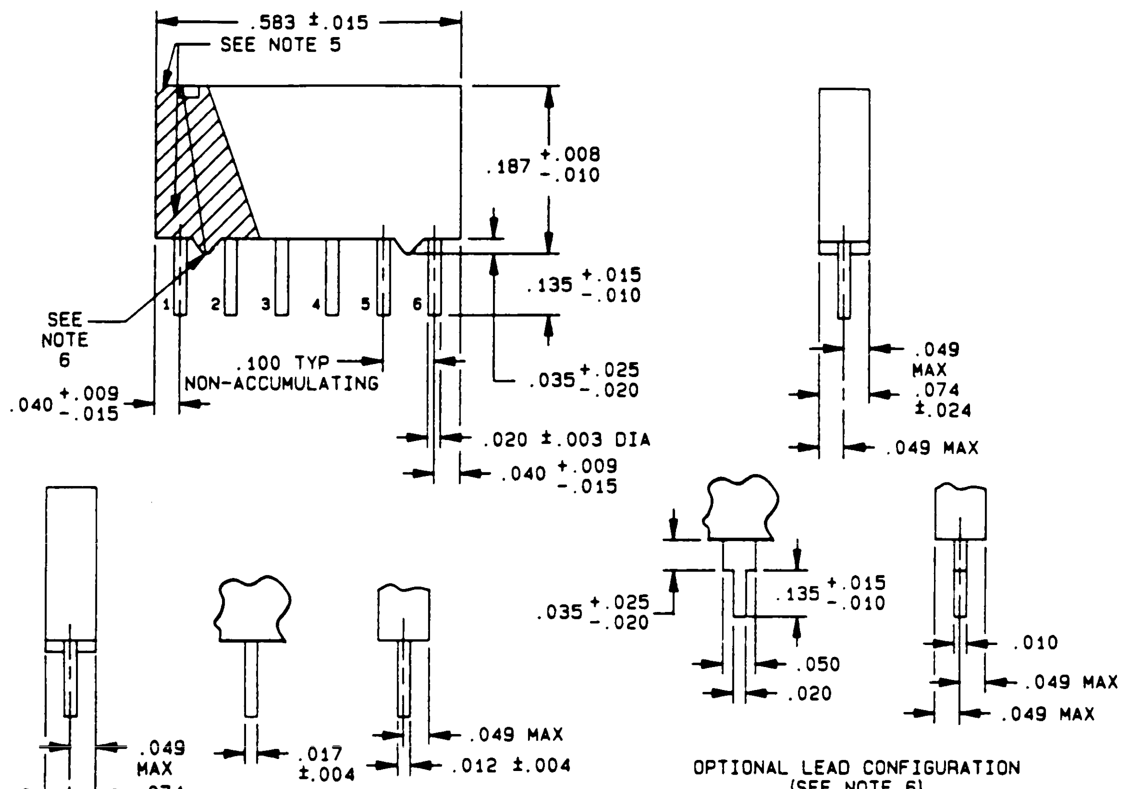
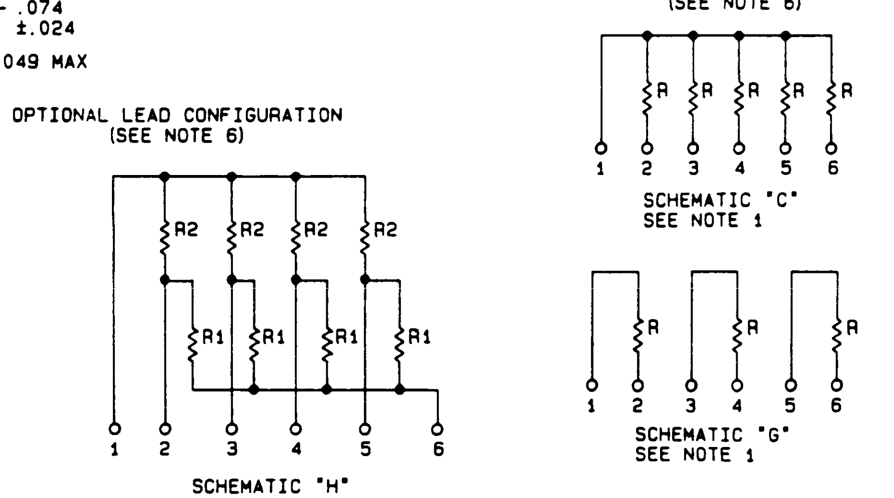


FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ070





Inches	mm
.003	0.08
.005	0.13
.008	0.20
.009	0.23
.010	0.25
.012	0.30
.013	0.33
.014	0.36
.015	0.38
.017	0.43
.020	0.51
.030	0.76
.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

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ080

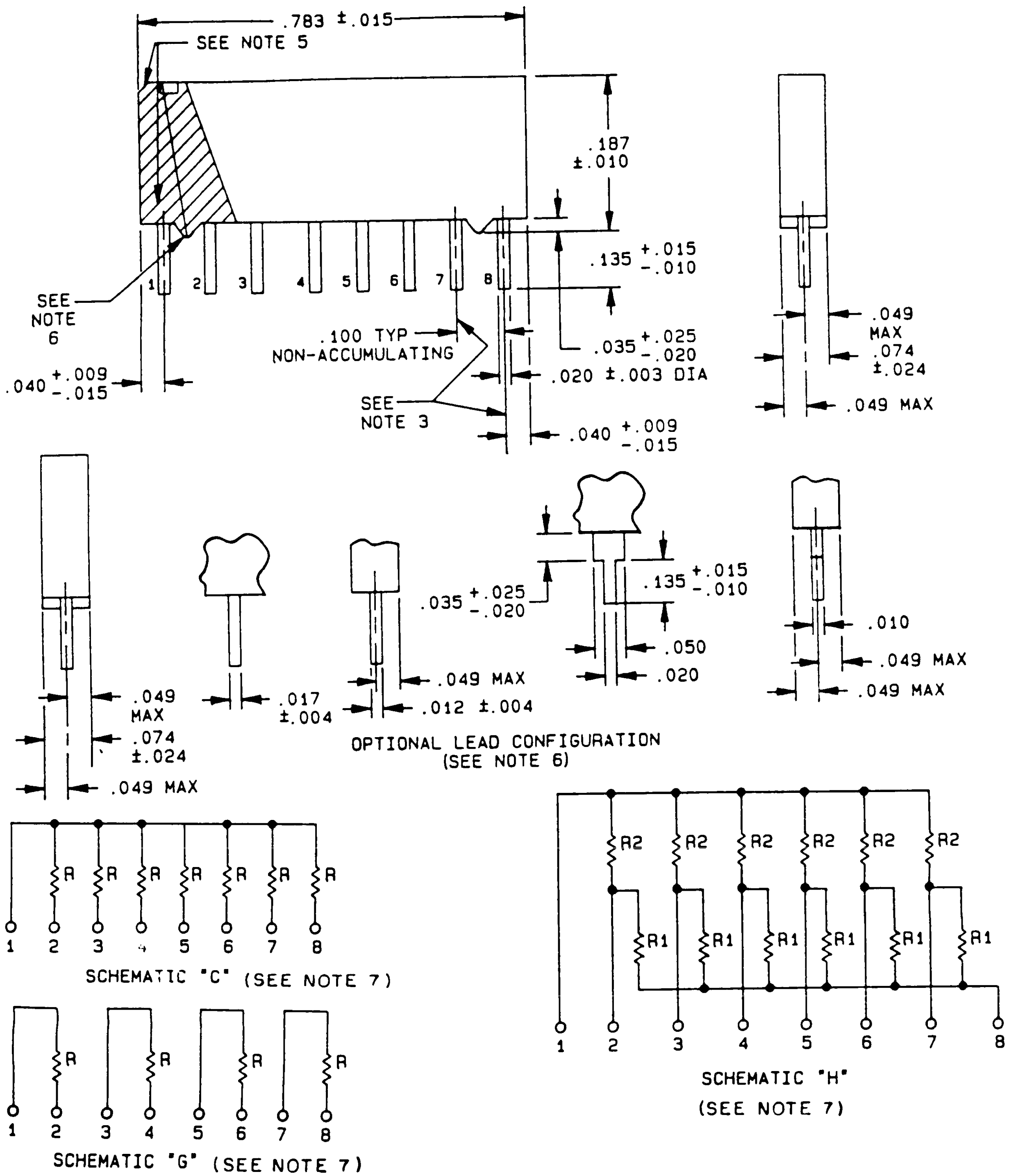
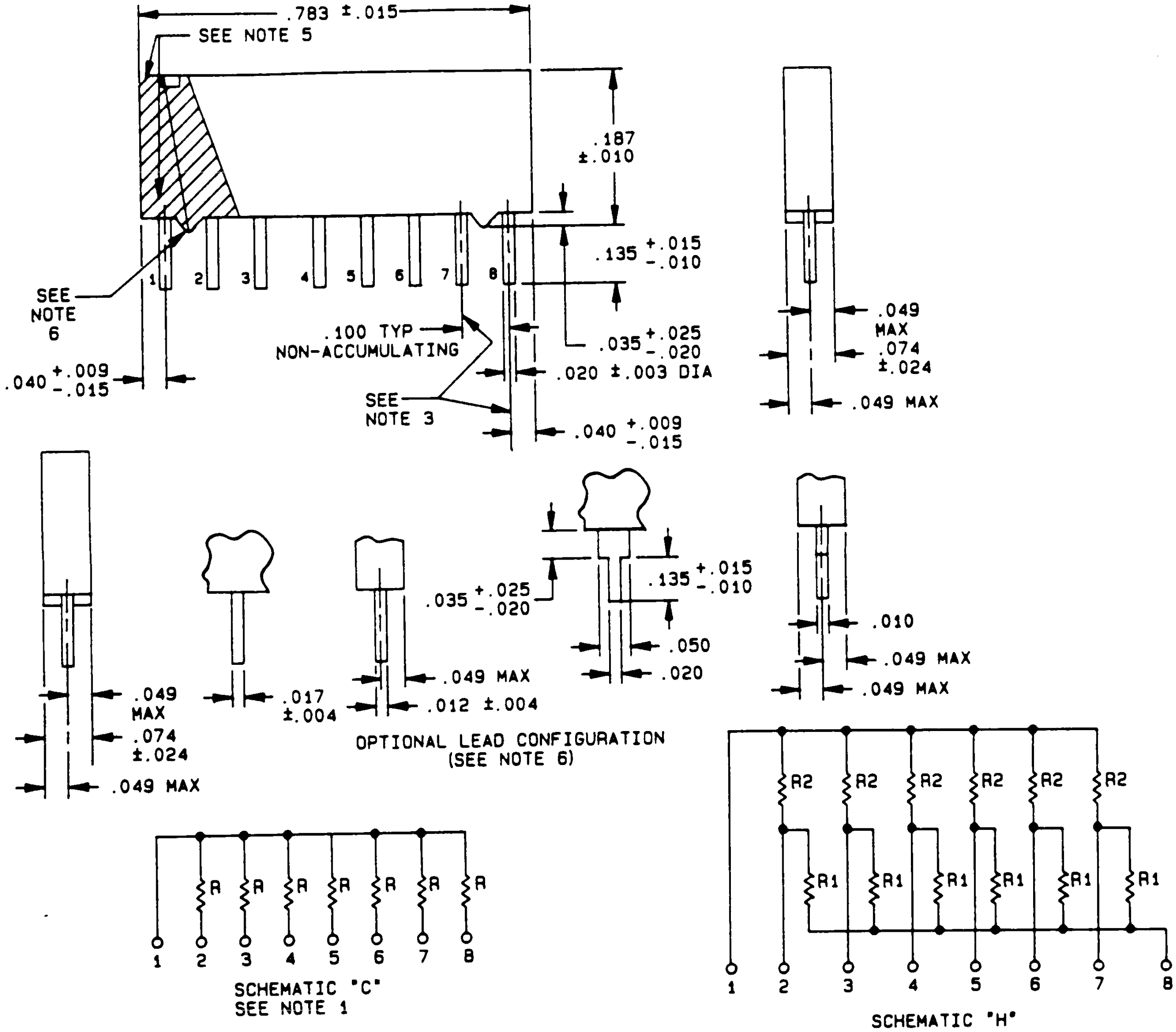
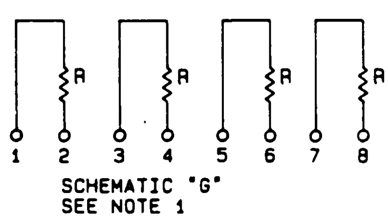


FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ080

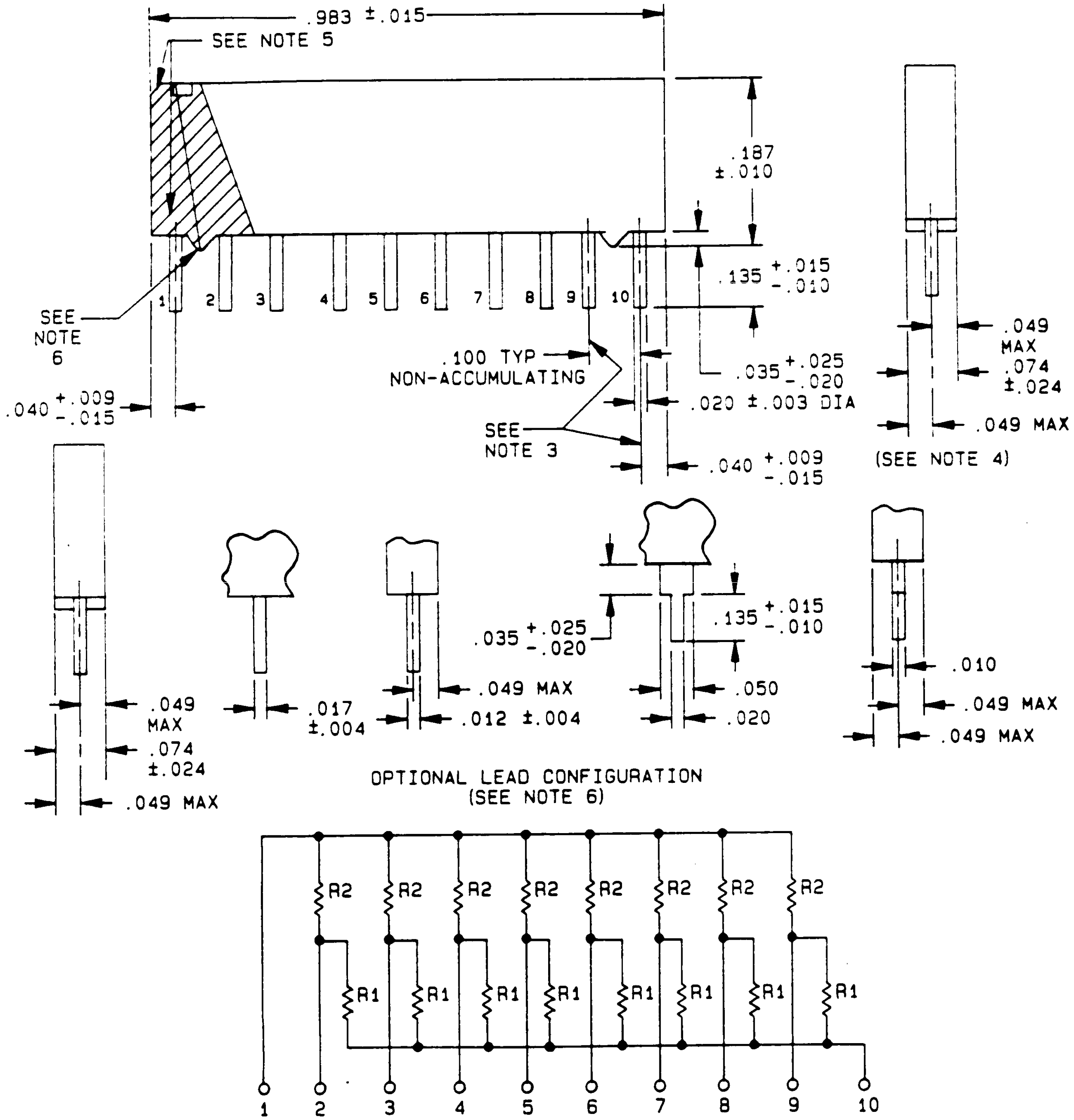




Inches	mm	Inches	mm
.003	0.08	.024	0.61
.004	0.10	.030	0.76
.005	0.13	.040	1.02
.009	0.23	.049	1.24
.010	0.25	,050	1.27
.012	0.30	.074	1.88
.014	0.36	.089	2.26
.015	0.38	.100	2.54
.017	0.43	.135	3.43
.020	0.51	.187	4.75
		.783	19.89

FIGURE 501-3. Fixed film resistor networks - Continued.

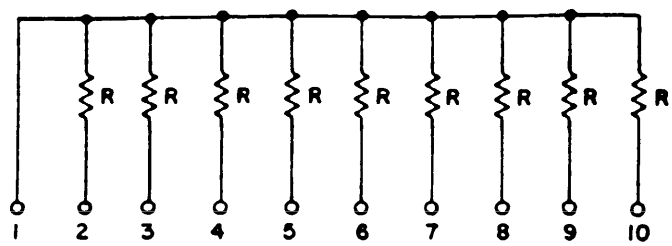
STYLE RZ090



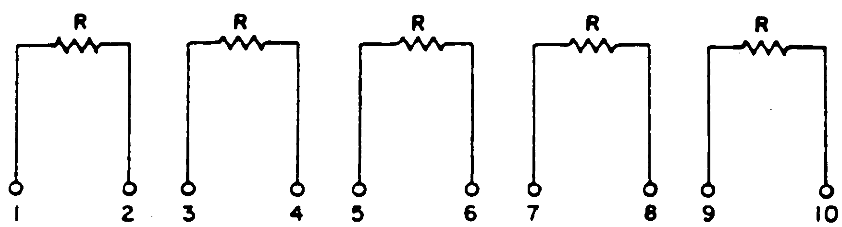
SCHEMATIC "H"

FIGURE 501-3. Fixed film resistor networks - Continued.

STYLE RZ090



SCHEMATIC C (SEE NOTE 7)



SCHEMATIC G (SEE NOTE 7)

Inches	mm	Inches	mm
.003	0.08	.024	0.61
.004	0.10	.030	0.76
.005	0.13	.040	1.02
.009	0.23	.049	1.24
.010	0.25	.050	1.27
.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	.187	4.75
		.983	24.97

NOTES:
1. Unless otherwise specified, tolerances are ±.005 (0.13 mm).
2. The picturization of the styles above 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 to point of emergence of the lead from the body.
5. Pin 1 locator shall be a dot, notch, stripe, or numeral 1 adjacent to pin number 1, in the shaded area; additional marking may be placed on the top edge where the bevel may be located.
6. 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.
7. All resistors are equal in value.

FIGURE 501-3. Fixed film resistor networks - Continued.

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 dissipation 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.

TABLE 501-II. 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	.05	.65	.05	.65
Schematic J	.05	1.2	.05	1.2	.05	1.2	.025	.6	.025	.6
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	.05	.75	.05	.75
Schematic J	.1	1.5	.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	.0625	.812	.0625	.812
Schematic J	N/A	N/A	.06	1.44	.06	1.44	.031	.75	.031	.75
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	.0625	.94	.0625	.94
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	"	"	"	"

TABLE 501-I. Performance characteristics - Continued.

Features	H		K		M		V		C	
Mininum 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 used 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, cobalt, 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
RTH 44	.20 W

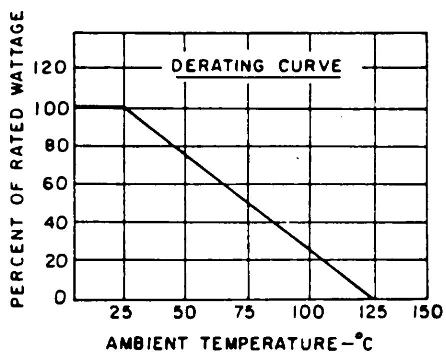


FIGURE 502-I. Power ratings and derating curve.

2.1.3 Zero-power resistance tolerance. The zero-power resistance tolerance varies according to variations in temperature and shall be in accordance with table 502-1.

TABLE 502-1. 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

2.3.5 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 he 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 PIN designation. The PIN designation is used for identifying and describing he resistor as shown on 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 failures".

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	
RTH44	2 mW/°C		2 mW/°C		2 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	
RTH44	20 seconds		20 seconds		20 seconds		---	
Minimum and maximum resistance values	Min	Max	Min	Max	Min	Max	Min	Max
RTH06	68Ω	560Ω	630Ω	4700Ω	7.5 kΩ	75 kΩ	---	---
RTH08	27Ω	180Ω	180Ω	1800Ω	2.2 kΩ	22 kΩ	---	---
RTH10	10Ω	82Ω	68Ω	330Ω	1 kΩ	6.8 kΩ	---	---
RTH22	---	---	---	---	---	---	10Ω	39 kΩ
RTH42	---	---	---	---	---	---	10Ω	10 kΩ
RTH44	300Ω	-3 kΩ	100Ω	10 kΩ	15 kΩ	500 kΩ	---	---
Features								
Moisture resistance								
RTH06	5%		5%		5%		---	
RTH08	5%		5%		5%		---	
RTH10	5%		5%		5%		---	
RTH22	---		---		---		5%	
RTH42	---		---		---		3%	
RTH44	5%		5%		5%		---	
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%	

TABLE 502-V. Performance characteristics - Continued.

	A	B	C	D
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 identified 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:

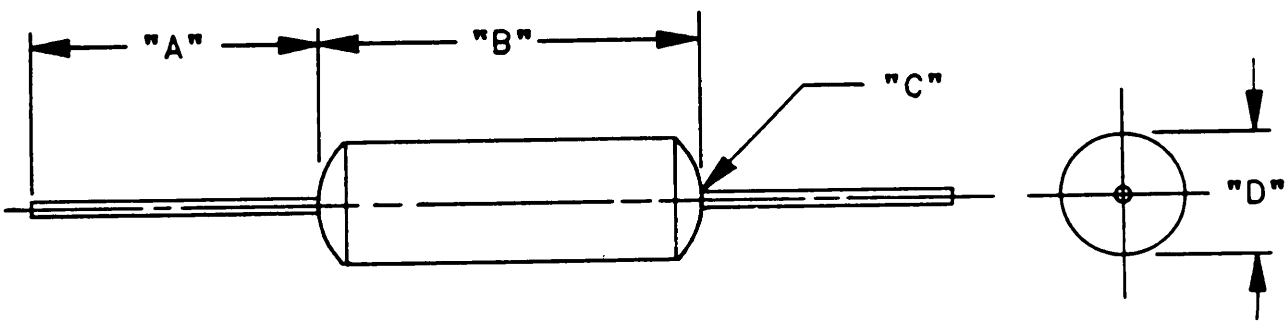
100 - - - - - 10 ohms
101 - - - - - 100 ohms
102 - - - - - 1,000 ohms
103 - - - - - 10,000 ohms
104 - - - - - 100,000 ohms

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.

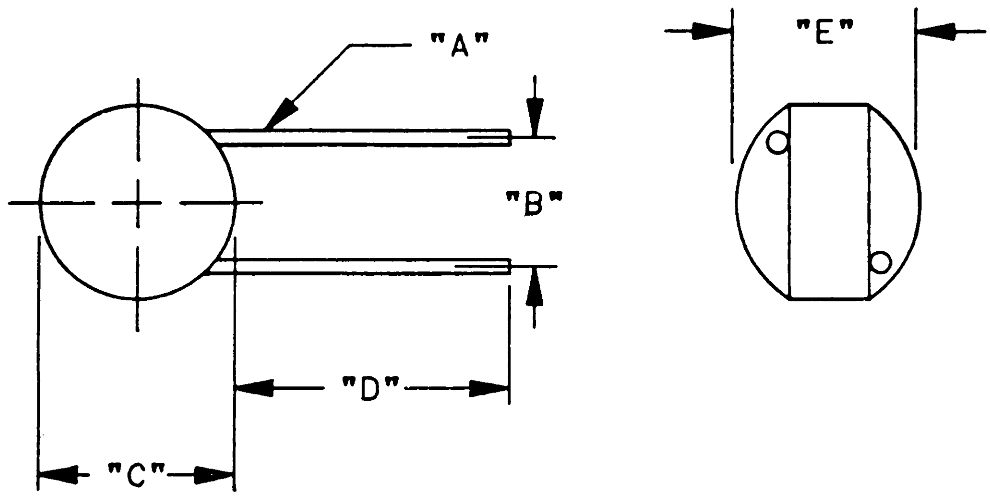
FIGURE 502-2. PIN example.



Inches	mm	Inches	mm
.003	0.07	.14	3.6
.010	0.25	.285	7.23
.015	0.38	.41	10.4
.020	0.50	1.20	30.5
.025	0.63	1.25	31.8
.10	2.5		

Style	A	B	C	D
RTH22	1.25	.41 ±.02	.025 ±.003	.14 ±.02
RTH42	1.20	.285 ±.015	.020 ±.003	.10 ±.010

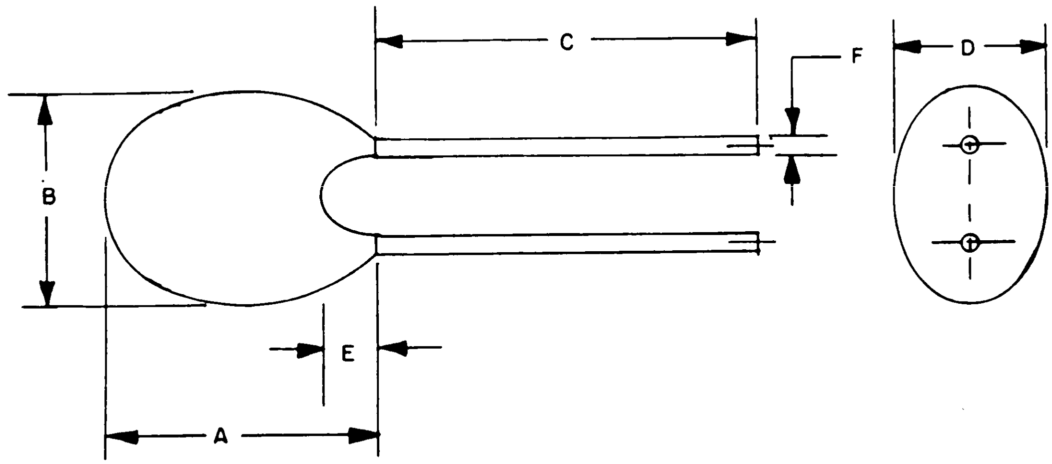
FIGURE 502-3. Thermally sensitive resistor axial lead.



Style	A	B	C	D	E
RTH06	.020 ±.003	.11	.25 ±.05	1.50	.26
RTH08	.025 ±.003	.24	.44 ±.06	1.50	.36
RTH10	.032 ±.003	.41	.85 ±.07	1.50	.45

Inches	mm	Inches	mm
.003	0.07	.25	6.4
.020	0.50	.26	6.6
.025	0.63	.36	9.1
.032	0.81	.41	10.4
.05	1.3	.44	11.2
.06	1.5	.45	11.4
.07	1.8	.85	21.6
.11	2.8	1.50	38.1
.24	6.1		

FIGURE 502-4. Thermally sensitive resistor radial lead.



Inches	mm
.001	0.03
.0126	0.380
.030	0.76
.100	2.54
.125	3.18
.135	3.43

Style	A	B	C	D	E	F dia
RTH44	.250 max	.100 ±.030	1.5 min	.135 max	.125 max	.0126 ±.001

FIGURE 502-5. Thermally sensitive resistor radial lead.

SECTION 503

RESISTOR, VOLTAGE SENSITIVE (VARISTOR, METAL-OXIDE)

(APPLICABLE SPECIFICATION: MIL-R-83530)

1. SCOPE

1.1 Scope. This section covers the general requirements for voltage sensitive resistors (varistors) to be used for suppressing transients in electronic circuitry.

2. APPLICATION INFORMATION

2.1 Style selection.

2.1.1 Construction. The structure of the body consists of a matrix of conductive zinc oxide grains separated by grain boundaries providing P-N junction semiconductor characteristics. Composition is primarily of zinc oxide with small addition of cobalt, manganese, and other oxides.

2.1.2 Power rating. The average power dissipation rating applicable to parts covered by this specification shall be 1.0 W at +85°C. For varistors operated at ambient temperatures in excess of +85°C, the voltage shall be derated in accordance with figure 503-I.

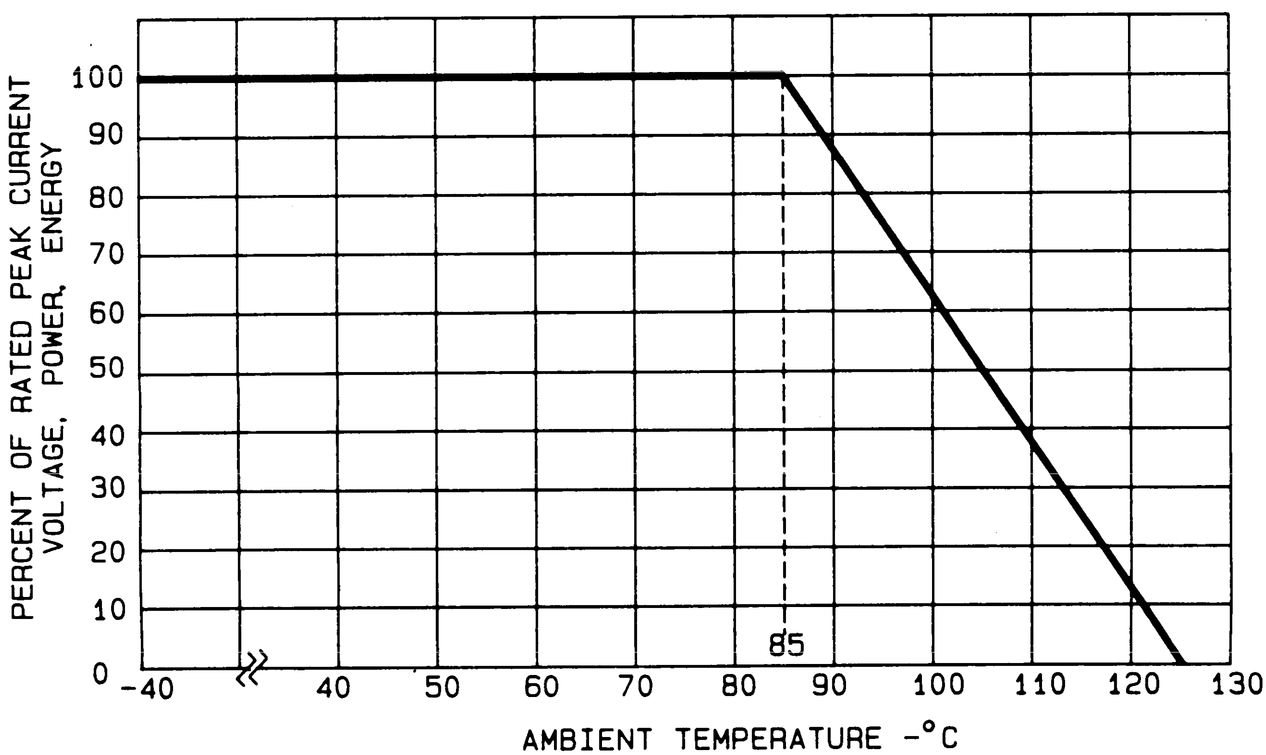


FIGURE 503-I. Current voltage, power, energy rating vs temperature.

2.2 Definitions.

a. Varistor. Is a voltage dependent, nonlinear device which has an electrical behavior similar to back-to-back zener diodes.

b. Nominal varistor voltage. The voltage across the varistor measured at a specified dc current of specified duration. Specification uses 1 mA for 5 seconds.

c. Clamping voltage. The peak voltage across the varistor measured under conditions of a specified peak impulse.

d. Peak current rating. The maximum recurrent peak current which may be applied for a specified duty cycle and waveshape.

e. Energy rating. The maximum allowable energy for a single impulse current waveform with continuous voltage applied.

3. ITEM IDENTIFICATION. (See table 503-I).

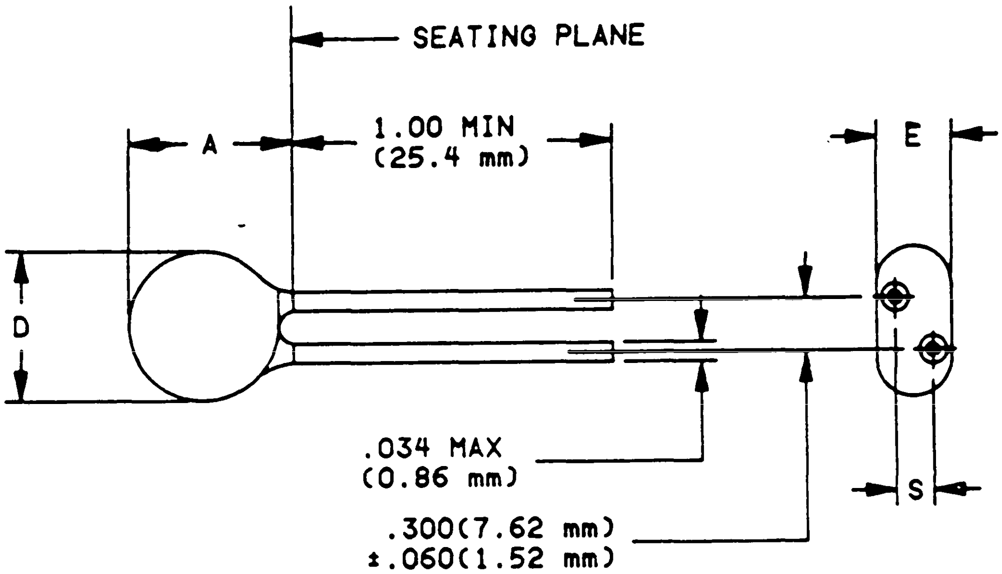
3.1 PIN designation. The PIN designation is used for identifying and describing he resistor as shown in table 503-I.

3.2 Performance characteristics. Performance characteristics are as shown in table 503-I.

3.3 Nominal varistor voltages. Voltage values shall follow table 503-I.

TABLE 503-I. Voltages and characteristics.

PIN	Nominal varistor voltage (V)	Tolerance (%)	Voltage rating (V) rms	Voltage rating (V) dc	Energy rating (joules)	Clamping voltage at 100A (V)	Capacitance at 1 MHz (pF)	Clamping voltage at peak current rating (6000A) (V)
M83530/1-2000B	200	±10	130	175	50	325	3800	570
M83530/1-2200D	220	+10, -5	150	200	55	360	3200	650
M83530/1-4300E	430	+5, -10	275	369	100	680	1800	1200
M83530/1-5100E	510	+5, -10	320	420	120	810	1500	1450



A		D		E		S			
Max		Max		Max		Min		Max	
Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1.10	27.94	0.95	24.13	0.32	8.13	.054	1.37	0.26	6.60

FIGURE 503.2. Style RVS10 varistors, dimensions and configuration.