

MILITARY SPECIFICATION

RESISTORS, ADJUSTABLE, WIREWOUND, POWER

*This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.*

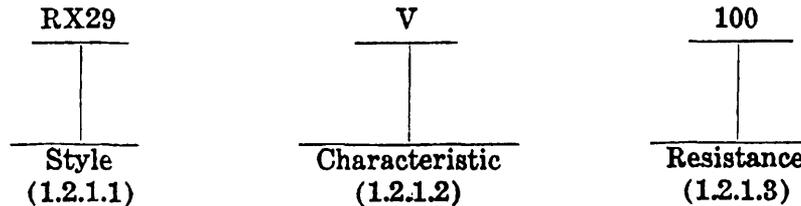
1. SCOPE

1.1 Scope. This specification covers power, wirewound, adjustable resistors for use in electrical, electronic, communication, and associated equipment. These resistors have a resistance range of 1 to 15,000 ohms, inclusive, and a resistance tolerance of  $\pm 5$  percent. The power ratings (see table II and 3.1) cover a range of 11 to 210 watts, inclusive. These power ratings are applicable only

when the maximum resistance is engaged in the circuit. When only a portion of the resistance element is engaged, the power rating is reduced in approximately the same proportion as the resistance.

1.2 Classification.

1.2.1 Type designation. The type designation shall be in the following form, and as specified (see 3.1 and 6.1):



1.2.1.1 Style. The style is identified by the two-letter symbol RX followed by a two-digit number; the letters identify power, wirewound, adjustable resistors, and the number identifies the size of the resistor.

1.2.1.2 Characteristic. The characteristic is identified by a single letter which identifies the maximum continuous operating temperature and the high-ambient-temperature derating of resistors, in accordance with table I.

TABLE I. Characteristic

Symbol	Maximum continuous operating temperature <sup>1</sup>	Derating curve
V .....	350° C	(See fig. 1)

<sup>1</sup> This temperature is also the maximum permissible hotspot surface temperature.

1.2.1.3 Resistance. The nominal resistance value expressed in ohms is identified by a

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three-digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. Where fractional values of an ohm, and values of less than 10 ohms, are required, the letter R is substituted for one of the significant digits to represent the decimal point. When the letter R is used, the last digit becomes significant. The following are examples of symbols for resistance values:

- 1R0 = 1.0 ohm
- 100 = 10 ohms
- 101 = 100 ohms
- 102 = 1,000 ohms
- 103 = 10,000 ohms

1.2.1.3.1 *Decade of resistance values.* Resistance values in all decades for all styles shall correspond to the values specified in the 10 to 100 decade listed below. For minimum and maximum nominal total resistance values, see 3.1.

*Decade 10 to 100 of resistance values*

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

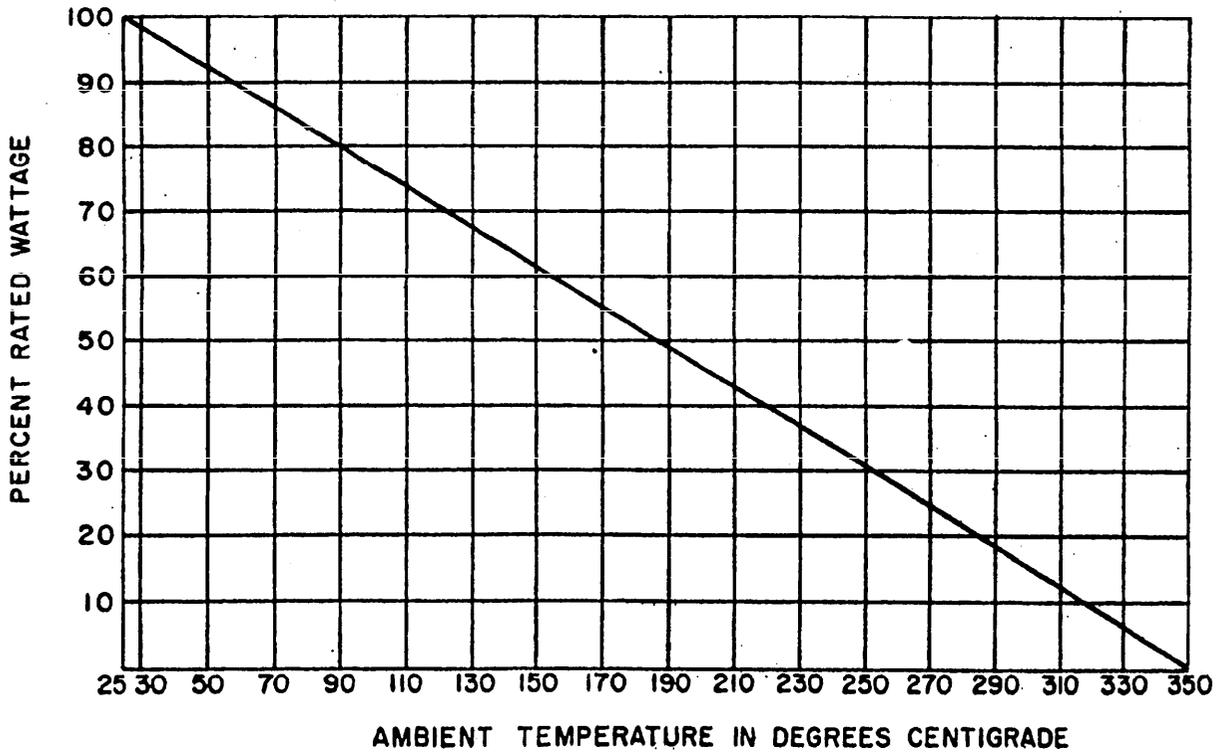


FIGURE 1. *Derating curve for high ambient temperatures*

1.2.2 *Power ratings.* The nominal power ratings for the various styles shall be in accordance with table II.

TABLE II. *Nominal power ratings (free space and still air<sup>1</sup>)*

Style	Power ratings Characteristic V
	<i>Watts</i>
RX29 .....	11
RX32 .....	17
RX33 .....	26
RX35 .....	55
RX36 .....	78
RX37 .....	113
RX38 .....	159
RX47 .....	210

<sup>1</sup> Free space is predicated on horizontal mounting of the resistor with no object closer than 12 inches to the resistor, except the mounting base which shall be not closer than 2 inches below the resistors. Still air is air with no circulation other than that created by the heat of the resistor being operated.

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

- PPP-B-566 — Boxes, Folding, Paperboard.
- PPP-B-585 — Boxes; Wood, Wirebound.
- PPP-B-591 — Boxes, Fiberboard, Wood-Cleated.
- PPP-B-601 — Boxes, Wood, Cleated-Plywood.
- PPP-B-621 — Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 — Boxes, Fiber.
- PPP-B-665 — Boxes; Paperboard, Metal Stayed (Including Stay Material).

- PPP-B-676 — Boxes, Set-Up, Paperboard.
- PPP-T-76 — Tape, Pressure-Sensitive Adhesive, Paper, Water Resistant.
- PPP-T-97 — Tape; Pressure-Sensitive Adhesive, Filament Reinforced.

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- MIL-P-116 — Preservation, Methods of.
- MIL-B-10377 — Boxes, Wood, Cleated, Veneer, Paper Overlaid.
- MIL-L-10547 — Liners, Case, Waterproof.

STANDARDS

MILITARY

- MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 — Marking for Shipment and Storage.
- MIL-STD-130 — Identification Marking of U. S. Military Property.
- MIL-STD-202 — Test Methods for Electronic and Electrical Component Parts.

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 *Other publications.* The following documents form a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

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## NATIONAL BUREAU OF STANDARDS

### Handbook H28 — Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.)

#### OFFICIAL CLASSIFICATION COMMITTEE

##### Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, One Park Avenue, at 33rd Street, New York 16, N. Y.)

## 3. REQUIREMENTS

**3.1 Detail requirements for individual resistor types.** Detail requirements or exceptions applicable to individual types of resistors shall be as specified on figures 2 to 9, inclusive. In the event of any conflict between the general requirements of this specification and the detail requirements, the latter shall govern. (See 6.1).

**3.2 Qualification.** Resistors furnished under this specification shall be a product which has been tested, and has passed the qualification tests specified in 4.4, and has been listed on or approved for listing on the applicable Qualified Products List. (See 6.2).

**3.3 Material.** The material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the resistors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

**3.4 Design and construction.** Resistors shall be of the design, construction, and physical dimensions specified. (See 3.1). The resistors shall consist of tubes wound with a single layer of resistance wire (round, flat-wound ribbon) and protected, insofar as is necessary, by a coating or an inclosure of insulating, moisture-resistant material. The design of the resistors shall be such as to

preclude shorting of turns and to obtain a minimum voltage drop between adjacent turns.

#### 3.4.1 Windings.

**3.4.1.1 Wire.** The wire shall have no joints, welds, or bonds, except at end terminals. The wire shall possess a uniform cross section of conductor and insulation (if employed), and shall be as free as practicable from particles of impurities, grain growth, or other factors contributing to spot weakness. When the active resistance element has a cross-sectional area of less than 642 circular mills, round wire shall be used; when the area is 642 circular mils or over, flat-wound ribbon may be used. However, the term "wire" will be used throughout this specification to describe the resistance element. The cross-sectional area of the wire shall be the maximum consistent with other requirements specified herein, and in no case shall the nominal diameter be less than 0.004 inch, minus 5 percent.

**3.4.1.2 Pitch.** For round wire, the average winding pitch shall not exceed 300 percent of the wire diameter.

**3.4.1.3 Effective wire coverage.** Effective wire coverage is the winding length on the tube between points of departure from the normal winding pitch. The effective wire coverage of the resistors shall be such that not more than  $\frac{3}{4}$  inch on style RX29, 1 inch on styles RX32 and RX33, and  $1\frac{1}{8}$  inches on styles RX35, RX36, RX37, RX38, and RX47 of the overall body length shall remain uncovered (by wire).

**3.4.2 Protective coating or enclosure.** The resistance element of resistors shall be protected by a coating or an enclosure which shall completely cover the exterior of the resistance element, except for a uniform exposed portion, 90° nominal from the fixed terminals, along one side of the body, which shall not extend to a point closer than  $\frac{1}{16}$  inch from the connection between the wind-

ing and either end terminal. The protective coating shall be free from holes, fissures, chips, and other faults. The protective coating need not completely cover the junction caused by silver soldering or welding of the resistance element to the terminals, provided that no portion of any resistance element wound with wire of 101 circular mils or less is exposed. Cracking of protective coating on resistors wound with wire of 101 circular mils or more shall not be cause for failure.

**3.4.3 Terminals.** Connection of terminals to resistor windings shall result in a joint that is mechanically strong. When necessary, terminals shall be suitably treated to facilitate soldering. They shall be firmly secured to the tube and shall not be solely dependent on the protective coating for mechanical anchorage. All terminals shall be so designed as to permit the secure crimping or hooking of 0.064-inch (AWG size 14) wire without depending upon soldering for mechanical strength. They shall support the wire without deformity. All terminals shall be radially straight and within 10° of a plane passing through one of the terminals and the longitudinal axis of the resistor.

**3.4.3.1 Adjustable terminals.** Adjustable terminals shall make positive continuous contact with the turns of the winding, and shall be designed for fastening securely in the desired position.

**3.5 Threaded parts.** Where applicable, all threaded parts shall be in accordance with Handbook H28.

**3.6 Voltage rating.** Resistors shall have a rated direct-current (dc) continuous working voltage or an approximate sine-wave root-mean-square (rms) continuous working voltage at commercial-line frequency corresponding to the power rating, as determined from the following formula:

$$E = \sqrt{PR}$$

Where:

E = Rated dc or rms continuous working voltage.

P = Power rating. (See 3.1).

R = Nominal resistance.

### 3.7 DC resistance.

**3.7.1 Total.** When resistors are measured as specified in 4.6.1.1, the total dc resistance shall be within 5 percent of the nominal resistance value. (See 1.2.1.3.1 and 3.1).

**3.7.2 Maximum engageable.** When resistors are measured as specified in 4.6.1.2, the dc resistance shall be within 20 percent of the value recorded in 3.7.1 for resistors of 2-inch nominal lengths or less, and within 10 percent of the value recorded in 3.7.1 for resistors over 2-inch nominal lengths.

**3.8 Resistance-temperature characteristic.** When resistors are tested as specified in 4.6.3, the resistance-temperature characteristic shall not exceed  $\pm 0.040$  percent per °C. for resistors having a resistance value up to and including 0.25 ohm per square inch of winding area, and shall not exceed  $\pm 0.026$  percent per °C. for all other resistors.

**3.9 Temperature.** When resistors are tested as specified in 4.6.4, there shall be no evidence of mechanical damage. Softening of solder during the test, except where it is used solely as a tinning agent, shall be considered a basis for failure.

**3.10 Dielectric withstanding voltage.** When tested as specified in 4.6.5, resistors shall not flashover, show any evidence of mechanical damage, arcing, or insulation breakdown nor change in resistance in excess of 0.1 percent.

**3.11 Insulation resistance.** When resistors are tested as specified in 4.6.6, insulation resistance shall be not less than 100 megohms.

**3.12 Power rating.** When tested as specified in 4.6.7, resistors shall dissipate the

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rated power input without exceeding the maximum applicable hot-spot surface temperature. (See table I). (The hot spot is the point or elemental area of maximum temperature on the external surface of a resistor.) There shall be no evidence of intermittent open-circuiting in the winding (see 3.1), and the change in resistance as a result of this test shall not exceed 0.5 percent.

**3.13 Thermal shock.** When resistors are tested as specified in 4.6.8, the change in resistance shall not exceed 2 percent; and there shall be no evidence of mechanical damage; nor any observable change in resistor coating, enclosure, or other parts which will adversely affect the performance of the resistor.

**3.14 Momentary overload.** When resistors are tested as specified in 4.6.9, the change in resistance shall not exceed 2 percent, and there shall be no evidence of mechanical damage, arcing, burning, or charring.

**3.15 Moisture resistance.** When resistors are tested as specified in 4.6.10, the change in total resistance and the resistance between the adjustable and fixed end terminals shall not exceed 5 percent. The insulation resistance shall not be less than 2.5 megohms. There shall be no evidence of mechanical damage, breaking, cracking, spalling, nor loosening of terminals or mounting hardware.

**3.16 Mechanical strength.** When resistors are tested as specified in 4.6.11, there shall be no evidence of mechanical damage.

**3.17 Terminal strength.** When resistors are tested as specified in 4.6.12, there shall be no evidence of mechanical damage, nor breaking or loosening of terminals.

**3.18 Load life.** When tested as specified in 4.6.13, resistors shall dissipate not less than the rated power input, without exceeding a change in resistance of 5 percent between the initial measurement and any succeeding

measurement. There shall be no evidence of mechanical damage.

**3.19 Marking.** Resistors shall be marked in accordance with Standard MIL-STD-130. The type designation and the manufacturer's name or code symbol, or both, shall be marked on the body of the resistor, parallel to the longitudinal axis. There shall be no space between the symbols which comprise the type designation. If lack of space requires it, the type designation may appear on two lines. In this event, the type designation shall be divided between the style and the characteristic designations as shown in the following example:

RX29

V100

For resistors having a body of more than 2 inches nominal length, the resistance value in ohms preceded by the abbreviation for "resistance", and the power-rating value in watts followed by the abbreviation for "nominal", shall also be marked as shown in the following example:

RX33V162

RES 1600

26 W NOM

(Manufacturer's name or code symbol,  
or both)

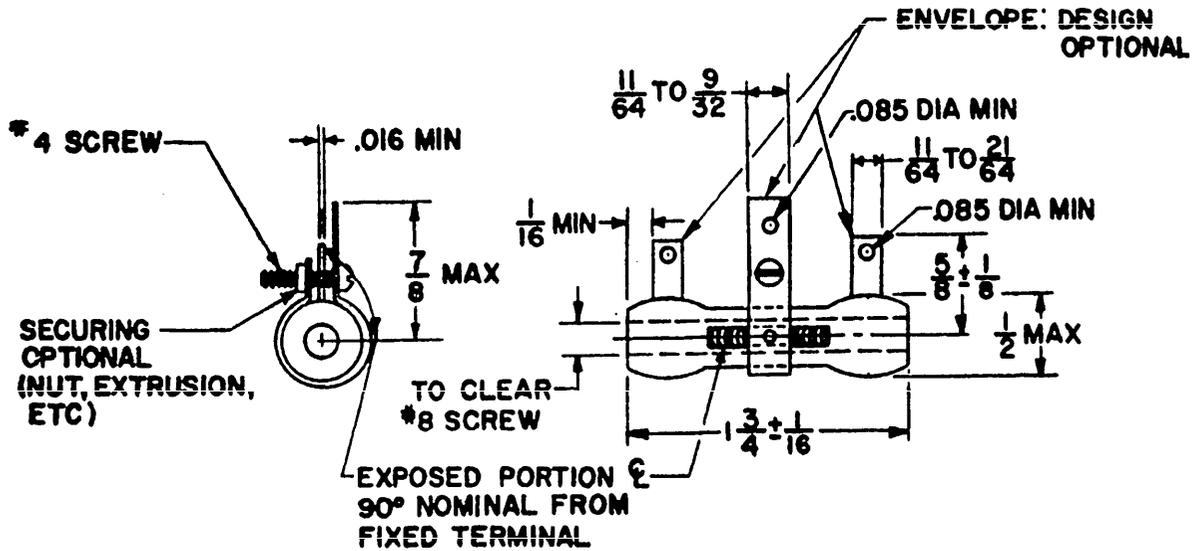
Marking shall remain legible at the end of all tests.

**3.20 Workmanship.** Resistors shall be processed in such a manner as to be uniform in quality and shall meet the requirements of 3.3 to 3.5, incl., 3.19 and 3.20.1, as applicable, and be free from other defects that will affect life, serviceability, or appearance.

**3.20.1 Soldering.** Where soldering is employed, only noncorrosive fluxes shall be used unless it can be shown that corrosive elements have been satisfactorily removed after soldering. Solder shall not be used for obtaining mechanical strength. Electrical connections shall be mechanically secure before

soldering and electrically continuous after soldering. Except for solder used to coat terminals, the solder used shall in no case

start to melt at a temperature of less than 360°C.

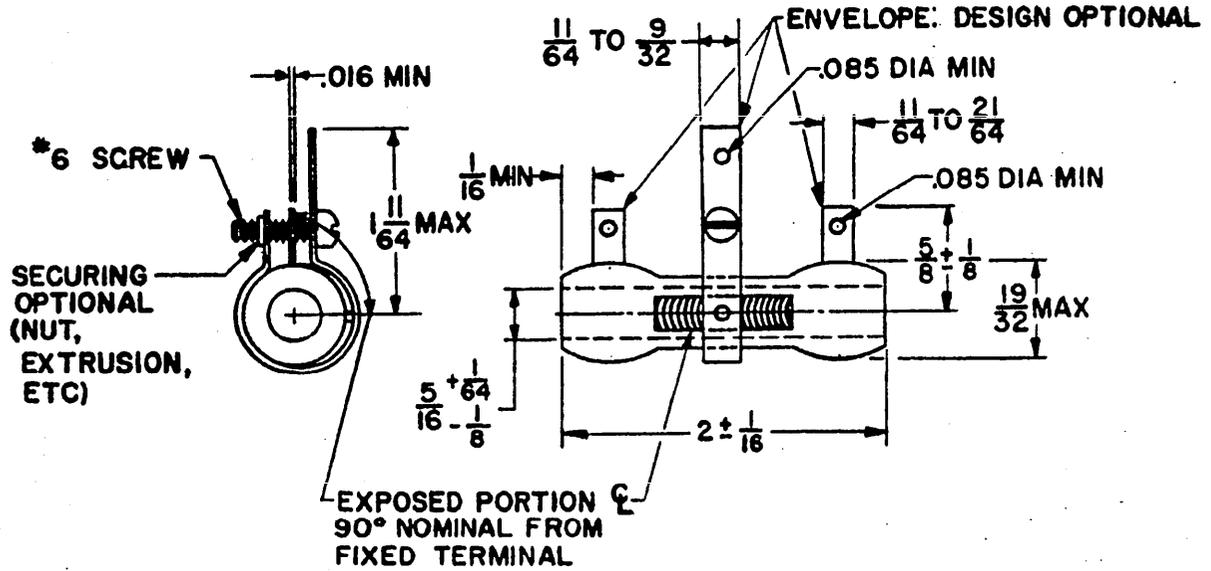


Characteristic	Power rating
V .....	Watts 11

- All dimensions in inches.
- Minimum nominal total resistance value ..... 1 ohm.
- Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 470 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 2. Style RX20, resistor

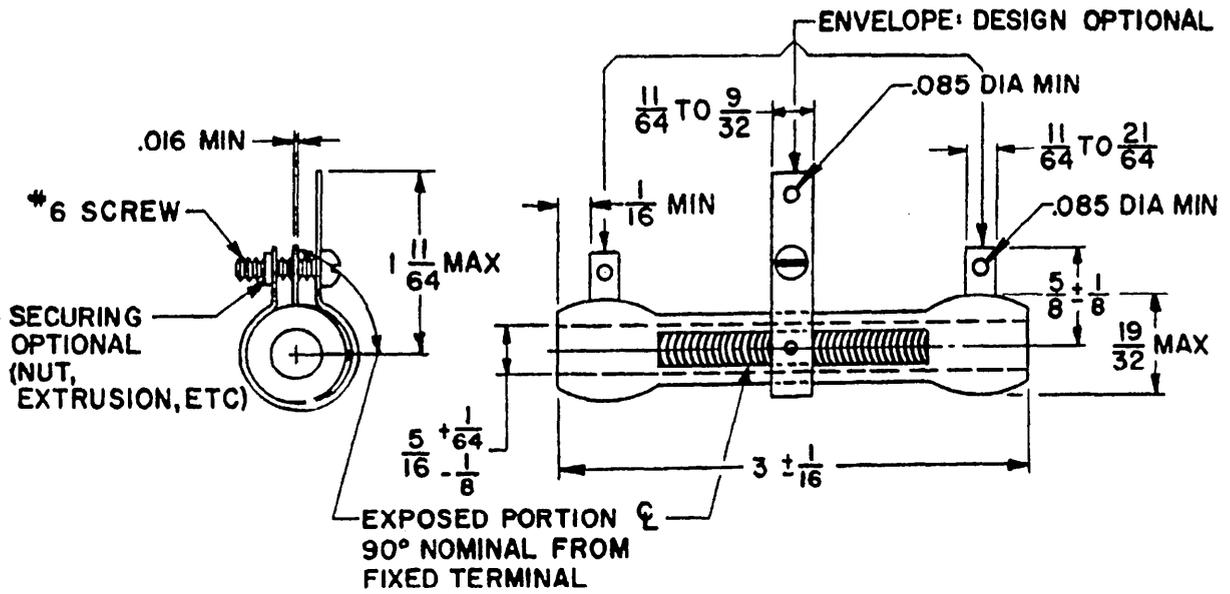


Characteristic	Power rating
V .....	Watts 17

1. All dimensions in inches.
2. Minimum nominal total resistance value ..... 1 ohm.
3. Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 910 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 3. Style RX32 resistor

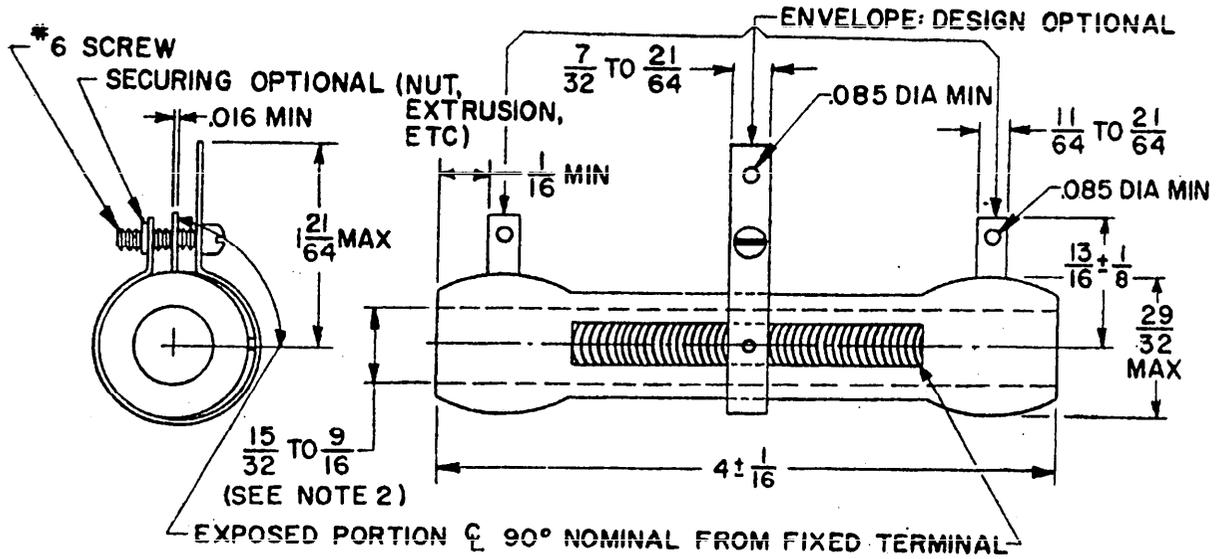


Characteristic	Power rating
V .....	Watts 26

1. All dimensions in inches.
2. Minimum nominal total resistance value ..... 1 ohm.
3. Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 1,500 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 4. Style RX33 resistor

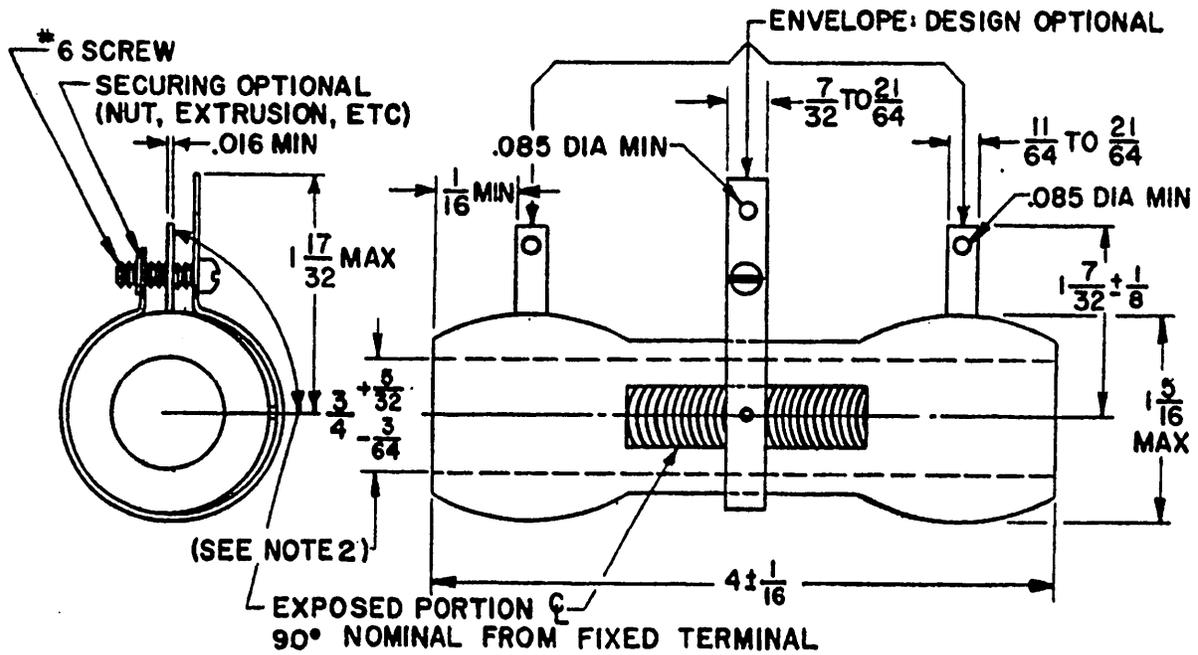


Characteristic	Power rating
V .....	Watts 55

1. All dimensions in inches.
2. This dimension applies for at least  $\frac{1}{2}$  inch from each end of the tube; the diameter of the remainder of the hole shall in no case be less than  $\frac{1}{4}$  inch.
3. Minimum nominal total resistance value ..... 1 ohm.
4. Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 3,600 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 5. Style RX35 resistor

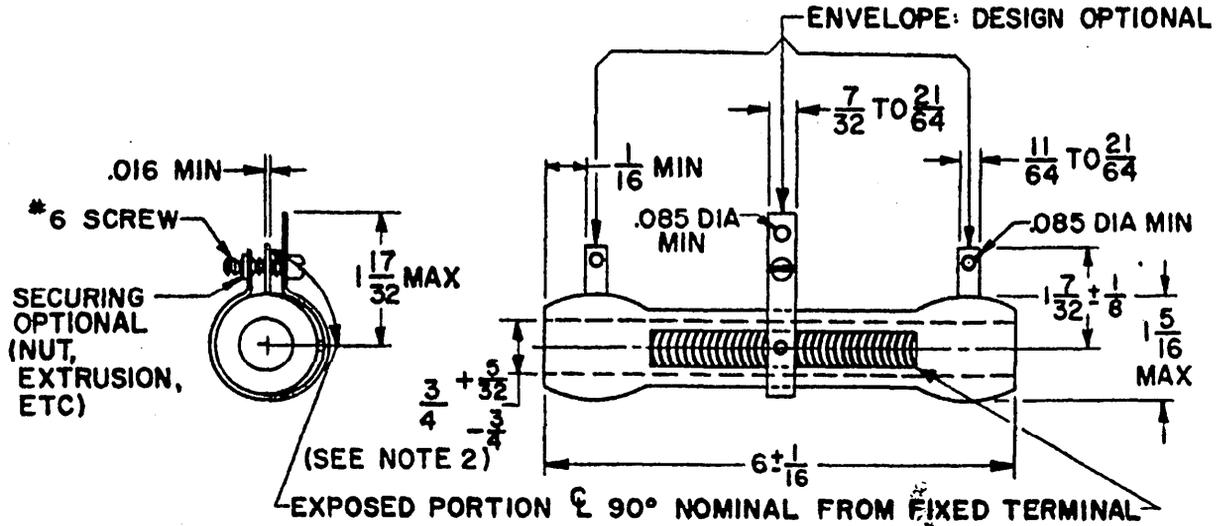


Characteristic	Power rating
V .....	Watts 78

- All dimensions in inches.
- This dimension applies for at least  $\frac{1}{4}$  inch from each end of the tube; the diameter of the remainder of the hole shall in no case be less than  $\frac{1}{4}$  inch.
- Minimum nominal total resistance value ..... 1 ohm.
- Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 5,100 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 6. Style RX36 resistor

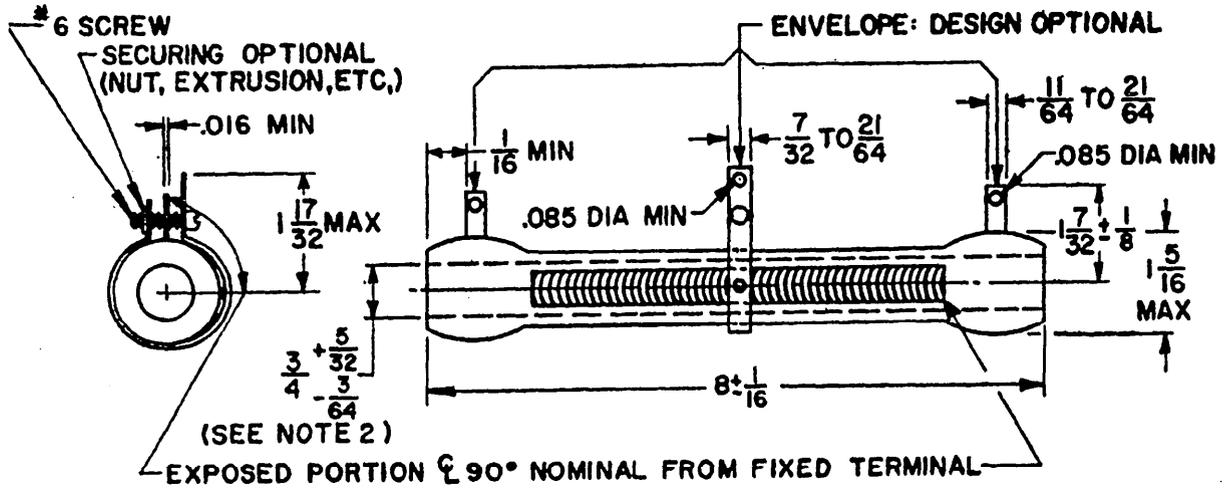


Characteristic	Power rating
V .....	Watts 113

1. All dimensions in inches.
2. This dimension applies for at least  $\frac{1}{2}$  inch from each end of the tube; the diameter of the remainder of the hole shall in no case be less than  $\frac{1}{4}$  inch.
3. Minimum nominal total resistance value ..... 1 ohm.
4. Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 8,200 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 7. Style RX37 resistor

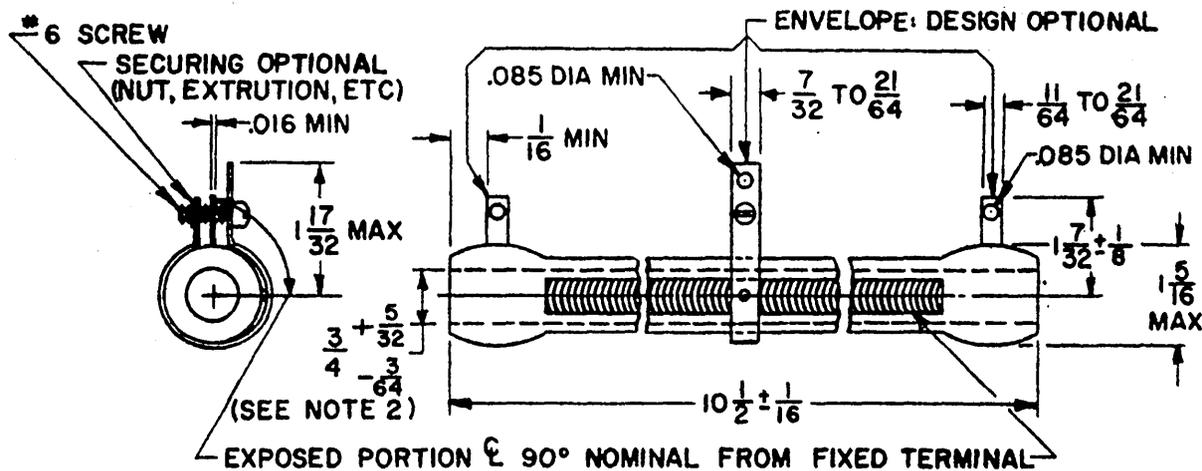


Characteristic	Power rating
V .....	Watts 159

- All dimensions in inches.
- This dimension applies for at least  $\frac{1}{2}$  inch from each end of the tube; the diameter of the remainder of the hole shall in no case be less than  $\frac{1}{4}$  inch.
- Minimum nominal total resistance value ..... 1 ohm.
- Maximum nominal total resistance value based on the use of 0.004-inch diameter wire ..... 11,000 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 8. Style RX38 resistor



Characteristic	Power rating
V .....	Watts 210

1. All dimensions in inches.
2. This dimension applies for at least  $\frac{1}{2}$  inch from each end of the tube; the diameter of the remainder of the hole shall in no case be less than  $\frac{1}{4}$  inch.
3. Minimum nominal total resistance value ..... 1 ohm.
4. Maximum nominal total resistance value based on the use of 0.004-inch diameter wire .....15,000 ohms.

Note. For information on supplementary insulation and standard bracket assembly (mounting hardware), see 6.6 and 6.7.1.

FIGURE 9. Style RX47 resistor

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for inspection.

4.1.1 *Supplier.* Unless otherwise specified herein, the supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Unless otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government, as specified in the contract or order.

4.1.1.1 *Test equipment and inspection facilities.* Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The supplier shall establish calibration of inspection equipment to the satisfaction of the Government.

4.1.1.2 *Additional inspection.* Nothing specified herein shall preclude the supplier from taking such additional samples and making such additional inspection as he may deem necessary or desirable to assure conformance of the resistors to this specification.

4.1.2 *Government.* Acceptance of the resistors shall be based upon verification by the Government of the supplier's compliance with the requirements of this specification. The Government may, at its option, repeat any or all of the inspections specified herein. (See 6.3).

4.2 *Classification of inspection.* The examination and testing of resistors shall be classified as follows:

- (a) Qualification inspection. (See 4.4).
- (b) Acceptance inspection. (See 4.5).
  1. Inspection of product for delivery. (See 4.5.1).
  2. Inspection of preparation for delivery. (See 4.5.2).

4.3 *Inspection conditions.* Unless otherwise specified herein, all inspections shall be made at room ambient temperature, relative humidity, and pressure.

4.4 *Qualification inspection.* Qualification inspection will be performed at a laboratory designated by the Government. (See 6.2).

4.4.1 *Sample.* The number of sample units comprising a sample of resistors to be submitted for qualification inspection shall be as specified in the appendix to this specification.

4.4.2 *Test routine.* The coated or enclosed sample units will be subjected to the qualification inspection specified in table III, in the order shown. All coated or enclosed sample units will be subjected to the test and examinations of group I. These sample units will then be divided equally into two groups, for groups II and III, and subjected to the tests for their particular group. The uncoated or unenclosed sample units will be subjected to the examinations of group IV.

4.4.3 *Defectives.* Defectives in excess of those allowed in table III will be cause for refusal to grant qualification.

### 4.5 Acceptance inspection.

4.5.1 *Inspection of product for delivery.* Inspection of products for delivery shall consist of groups A, B, and C.

4.5.1.1 *Inspection lot.* An inspection lot shall consist of any one style, or a combination thereof, in either resistor styles RX29, RX32, RX33, and RX35, or styles RX36, RX37, RX38, and RX47, produced under essentially the same conditions, regardless of resistance value, and offered for inspection at one time.

4.5.1.2 *Resubmitted lots.* If an inspection lot is rejected, the supplier may replace it with a new lot, rework it to correct the defects, or screen out the defective units, and submit it again for inspection. Resubmitted

TABLE III. Qualification inspection

Examination or test	Requirement paragraph	Method paragraph	Number of defectives allowed <sup>1</sup>
<i>Group I</i>			
Dc resistance .....	3.7	4.6.1	0
Visual and mechanical examination. <sup>2</sup> .....	3.1, 3.3 to 3.5 incl, 3.19 to 3.20.1 incl	4.6.2	
<i>Group II</i>			
Resistance-temperature characteristic .....	3.8	4.6.3	1 } 1
Temperature .....	3.9	4.6.4	
Dielectric withstanding voltage .....	3.10	4.6.5	
Insulation resistance .....	3.11	4.6.6	
Power rating .....	3.12	4.6.7	
Thermal shock .....	3.13	4.6.8	
Momentary overload .....	3.14	4.6.9	
Moisture resistance .....	3.15	4.6.10	
Mechanical strength .....	3.16	4.6.11	1
Terminal strength .....	3.17	4.6.12	
<i>Group III</i>			
Load life .....	3.18	4.6.13	1
<i>Group IV</i>			
Visual and mechanical examination .....	3.3 to 3.4.1.3 incl, 3.4.3, 3.20, and 3.20.1	4.6.2	0

<sup>1</sup> Failure of a resistor in one or more tests of a group will be charged as a single defective.

<sup>2</sup> Marking will be considered defective only if the marking is illegible.

lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots. Resubmitted lots shall be inspected, using tightened inspection.

4.5.1.3 *Group A inspection.* Group A inspection shall consist of the examinations and test specified in table IV, and shall be made on the same set of sample units, in the order shown.

4.5.1.3.1 *Sampling plan.* Statistical sampling and inspection shall be in accordance with Standard MIL-STD-105 for ordinary inspection. The acceptable quality levels (AQL) shall be as specified in table IV. Major and minor defects shall be as defined in Standard MIL-STD-105.

TABLE IV. Group A inspection

Examination or test	Requirement paragraph	Method paragraph	Defect classification	AQL (percent defective)	
				Major	Minor
Dc resistance .....	3.7	4.6.1	Major	1.0	...
Visual and mechanical examination:	...	4.6.2			
Overall body dimensions .....	3.4	...	Major	1.0	4.0
Other physical dimensions .....	3.4	...	Minor		
Terminals .....	3.4.3 and 3.4.3.1	...	Major		
Marking .....	3.19	...	Major	1.0	4.0
Workmanship .....	3.20 and 3.20.1	...	Minor		

4.5.1.4. *Group B Inspection.* Group B inspection shall consist of the tests specified in table V, in order shown.

TABLE V. *Group B inspection*

Test	Requirement paragraph	Method paragraph
Temperature .....	3.9	4.6.4
Dielectric withstanding voltage .....	3.10	4.6.5
Insulation resistance ....	3.11	4.6.6
Thermal shock .....	3.13	4.6.8
Momentary overload .....	3.14	4.6.9

4.5.1.4.1 *Sampling plan.* The sampling plan shall be in accordance with Standard MIL-STD-105 for small-sample inspection. Unless otherwise specified herein, normal inspection shall be used at the start of the contract. Small-sample reduced inspection procedure R-A shall be used. The AQL shall be 2.5 (percent defective) and the inspection level shall be 1.7 for normal and tightened inspection, and 1.6 for reduced inspection.

4.5.1.4.2 *Disposition of sample units.* Sample units which have been subjected to group B inspection shall not be delivered on the contract or order.

4.5.1.4.3 *Action in case of lot rejection.* When an inspection lot is rejected on group B inspection, the supplier shall immediately investigate the cause of failure and take corrective action to assure that subsequent lots do not contain the same defect or defects.

4.5.1.5 *Group C inspection.* Group C inspection shall consist of the tests specified in table VI, in the order shown. The inspection shall be performed quarterly on sample units that have been subjected to and have passed the groups A and B inspection, and semiannually on sample units that have passed the group A inspection, unless the Government considers it more practical to select a separate sample from the inspection lot for group C inspection.

TABLE VI. *Group C inspection*

Test	Requirement paragraph	Method paragraph	Number of defectives allowed <sup>1</sup>
<i>Quarterly</i>			
Resistance-temperature characteristic .....	3.8	4.6.3	} 1
Power rating .....	3.12	4.6.7	
Moisture resistance .....	3.15	4.6.10	
Mechanical strength .....	3.16	4.6.11	
Terminal strength .....	3.17	4.6.12	
<i>Semiannually</i>			
Load life .....	3.18	4.6.13	1

<sup>1</sup> Failure of a resistor in one or more tests of an inspection period will be charged as a single defective.

4.5.1.5.1 *Sampling plan.* Six sample units, of the greatest longitudinal-axis dimension and highest resistance value, shall be selected from resistors currently in production, quarterly and semiannually as specified in 4.5.1.5. If the number of defectives exceeds those allowed in table VI, the sample shall be considered to have failed.

4.5.1.5.2 *Disposition of sample units.* Sample units which have been subjected to group C tests shall not be delivered on the contract or order.

4.5.1.5.3 *Noncompliance.* If a sample fails to pass group C inspection, the supplier shall take corrective action on the materials or process, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C

inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Group A and B, inspection may be reinstated; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer.

**4.5.2 Inspection of preparation for delivery.** Sample items and packs shall be selected and inspected in accordance with Specification MIL-P-116 to verify conformance with requirements in section 5 of this specification.

**4.6 Methods of examination and test.**

**4.6.1 DC resistance (see 3.7).** The dc resistance shall be measured in accordance with method 303 of Standard MIL-STD-202 and as specified in 4.6.1.1 and 4.6.1.2. The following details and exceptions shall apply:

- (a) The same measuring instrument shall be used for any one test, but not necessarily for all tests.
- (b) Test voltage—Measurements of resistance shall be made by using a dc potential resulting in not more than 1 percent of rated wattage. (See 3.6). The voltage used for the initial measurement shall be used for all subsequent measurements.

**4.6.1.1 Total.** The dc resistance shall be measured as specified in 4.6.1 between the two fixed end terminals. For the initial tolerance determination, the total resistance shall be measured with the adjustable terminal removed from the resistor. (See 3.7.1).

**4.6.1.2 Maximum engageable.** The dc resistance shall be measured as specified in 4.6.1, between each fixed end terminal and

the adjustable terminal, with the latter positioned farthest from the fixed end terminal, while still engaging the bare resistance wire. (See 3.7.2).

**4.6.2 Visual and mechanical examination.** Resistors shall be examined to verify that the materials, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements. (See 3.1, 3.3 to 3.5 incl., and 3.19 to 3.20.1, incl.).

**4.6.3 Resistance-temperature characteristic (3.8).**

**4.6.3.1 Qualification inspection.** Resistors shall be tested in accordance with method 304 of Standard MIL-STD-202. The following detail and exception shall apply:

- (a) Test temperatures—As specified in table VII.
- (b) Measurement at end of each period—Total resistance shall be measured as specified in 4.6.1.1, at the temperature maintained during the period.

TABLE VII. Resistance-temperature-characteristic test ambient temperatures

Sequence	Test ambient temperature
	°C
1 .....	25
2 .....	-55
3 .....	25
4 .....	125
5 .....	200
6 .....	275
7 .....	350

<sup>1</sup> This temperature shall be considered the reference temperature for that in sequence 2.

<sup>2</sup> This temperature shall be considered the reference temperature for those in sequences 4 to 7, incl.

**4.6.3.2 Product acceptance inspection.** Resistors shall be tested as specified in 4.6.3.1, except that sequences 1, 2, 3, and 7 of table VII shall be performed only, in that order.

**4.6.4 Temperature.** Resistors shall be placed in an oven at room temperature. The

temperature of the oven shall then be elevated gradually to the maximum hotspot surface temperature of the resistor  $\pm 5^{\circ}\text{C}$ . (See table I). The period of the transition from room temperature to the hotspot surface temperature shall be accomplished in not more than 45 minutes. For product acceptance inspection, at the option of the supplier, the resistors may be placed in an oven whose temperature has already been brought up to approximately the hotspot surface temperature. The resistors shall be conditioned at the latter temperature for a period of 2 hours. They shall then be allowed to cool gradually to room temperature, after which they shall be visually examined for evidence of mechanical damage. (See 3.9).

**4.6.5 Dielectric withstanding voltage** (see 3.10). Resistors shall be tested in accordance with method 301 of Standard MIL-STD-202. The following details shall apply:

- (a) Special preparations—Resistors shall be mounted, without supplementary insulation, between two metal plates normal to the longitudinal axis of the resistor, one plate at each end, held firmly against the end of the resistor core by a through bolt. These plates shall be of sufficient size to extend beyond the resistor-terminal extremities. The adjustable terminal shall be positioned within  $\pm 5$  percent of the electrical center.
- (b) Magnitude of test voltage — 1,000 volts.
- (c) Nature of potential—Alternating-current (ac) supply at commercial-line frequency and waveform.
- (d) Points of application of test voltage Between the terminals tied together, and the mounting hardware and plates.
- (e) Examination and measurements — Total resistance shall be mea-

sured before and after the test. At the conclusion of the test, resistors shall be examined for evidence of mechanical damage, arcing, and insulation breakdown.

**4.6.6 Insulation resistance** (see 3.11). Resistors shall be tested in accordance with method 302 of Standard MIL-STD-202. The following details shall apply:

- (a) Test condition letter—A.
- (b) Special preparations—As specified, in 4.6.5(a).
- (c) Points of measurement—As specified in 4.6.5(d) with the positive lead connected to the winding and the negative lead to the mounting hardware.

**4.6.7 Power rating.** The adjustable terminal shall be positioned at one end as close to the fixed end terminal as possible while still engaging the bare resistance wire. The resistors shall be mounted horizontally with the exposed portion facing downward. Total resistance shall be measured as specified in 4.6.1.1. The resistors shall be supported without mounting hardware by means of their terminals in free space and still air (see<sup>1</sup> to table II) at an ambient temperature of  $25^{\circ} \pm 5^{\circ}\text{C}$ . (See 4.6.7.1). If the power rating is measured at any ambient temperature other than  $25^{\circ}\text{C}$ , a power-rating correction factor with reference to  $25^{\circ}\text{C}$  ambient temperature shall be applied in accordance with the derating curve shown on figure 1. Rated wattage from an ac supply at commercial-line frequency and waveform shall be applied to the fixed end terminals until thermal stability has been reached. During the test, added precaution shall be taken to determine the possibility of intermittent open-circuiting in the winding. The hotspot surface temperature shall be determined by the use of a thermocouple. (See 4.6.7.2). Measurement of resistance shall be made not less than 2 hours after removal of the load potential. (See 3.12).

4.6.7.1 *Measurement of ambient temperature.* The ambient temperature shall be measured on a level with, and at a point 12 inches from, the nearest part of the nearest resistor under test.

4.6.7.2 *Thermocouple.* The thermocouple junction shall rest on the hotspot, and the thermocouple wires shall hang down on opposite sides of the resistor. Precaution shall be taken that the thermocouple wire does not touch the exposed portion of the resistor. Weights of at least 2 ounces on each wire lead shall provide the pressure of the thermocouple junction against the surface of the resistor under test. The thermocouple shall be composed of wire 0.010 inch in diameter (AWG size 30), or smaller. The thermocouple wire shall not extend more than  $\frac{1}{8}$  inch beyond the junction. A negligible difference of potential may exist between the thermocouple and the resistor winding so as to prevent a possible dielectric failure of the coating.

4.6.8 *Thermal shock.* Resistors shall be mounted on a rack of low-heat conducting material. Following a measurement of total resistance (see 4.6.1.1), rated wattage from an ac supply at commercial-line frequency and waveform shall be applied until thermal stability has been reached. The power shall then be removed and, within 8 to 12 seconds, the resistors shall be subjected to an air temperature of  $-55^{\circ} \pm 5^{\circ}\text{C}$ . for a period of not less than 15 minutes nor more than 30 minutes. Total resistance shall again be measured not less than 2 hours after final exposure. Resistors shall then be examined for evidence of mechanical damage and change in any part of the resistor. (See 3.13).

4.6.9 *Momentary overload.* Resistors shall be mounted by their normal mounting means. Following a measurement of total resistance (see 4.6.1.1), a potential from an ac supply at commercial-line frequency and waveform which will result in 10 times the rated wattage (see 3.1) shall be applied to the resistors

for 5 seconds. In no case shall this voltage exceed 6,000 volts. Total resistance shall again be measured after the resistors have cooled to room temperature. Resistors shall then be examined for evidence of mechanical damage, arcing, burning, and charring. (See 3.14).

4.6.10 *Moisture resistance (see 3.15).* Resistors shall be tested in accordance with method 106 of Standard MIL-STD-202. The following details and exceptions shall apply:

- (a) *Mounting*—All resistors shall have their adjustable terminal positioned within  $\pm 5$  percent of electrical center. Resistors under load shall be mounted horizontally not less than  $2\frac{1}{2}$  inches apart and with their terminals pointing upward, as follows:
  1. One-half of the resistors shall be mounted by means of their associated hardware (see 3.1), with supplementary insulation.
  2. The remaining half of the resistors shall be mounted, without supplementary insulation, between two metal plates normal to the longitudinal axis of the resistor (one plate at each end) held firmly against the ends of the resistor by through bolts. These bolts shall be of sufficient size to extend beyond the extremities of the resistor terminals.
- (b) *Initial measurements* — Resistance between adjustable terminal and fixed end terminals, total resistance, and insulation resistance shall be measured as specified in 4.6.1, 4.6.1.1, and 4.6.6., respectively
- (c) *Load and polarization*—One-half of the resistors shall be subjected to load (see 4.6.10(a)1) and the remaining half to polarization (see 4.6.10(a)2).

1. **Load**—During the first 2 hours of each of steps 1 and 4, one-half the rated wattage from a dc supply, derated in accordance with the derating curve shown on figure 1 to the temperature attained at the end of the 2-hour period, shall be applied to each half of the resistor with the positive lead connected to the adjustable terminal, and a negative lead to each of the fixed end terminals. The negative terminals shall be electrically grounded to the mounting surface.
  2. **Polarization** — During steps 2 and 3, and 5 and 6, a potential of 100-volt dc shall be applied with the positive lead connected to the terminals tied together, and the negative lead connected to the mounting hardware.
- (d) **Final measurements** — At the end of the final cycle and while the resistors are still in the humidity chamber at the high-humidity condition, the resistance between the adjustable terminal and fixed end terminals, total resistance, and insulation resistance shall be measured as specified in 4.6.1, 4.6.1.1, and 4.6.6, respectively. Resistors shall then be examined for evidence of mechanical damage, breaking, cracking, spalling, loosening of terminals or mounting hardware. (The subsequent 4- to 24-hours conditioning period and measurements do not apply).

**4.6.11 Mechanical strength.** Resistors shall be supported  $\frac{1}{8}$  inch from each end and subjected to a transverse load of 50 pounds applied at the center of the resistor through a fulcrum having a radius of not less than 0.250 inch nor more than 0.375 inch. The load shall not be applied on the exposed portion of the resistor. Resistors shall then be ex-

amined for evidence of mechanical damage. (See 3.16).

**4.6.12 Terminal strength.** Resistors shall be firmly clamped and a direct pull of 10 pounds shall be applied to the hole of each fixed end terminal for at least 30 seconds, one terminal at a time, in the direction away from the resistor and parallel to the longitudinal axis. Resistors shall then be examined for evidence of mechanical damage, and breaking or loosening of terminals. (See 3.17).

**4.6.13 Load life (see 3.18).**

**4.6.13.1 Test conditions.** This test shall be conducted at an ambient temperature of  $25^{\circ} \pm 2^{\circ}$  C. Resistors shall be mounted by means of their associated hardware, and wire leads shall be soldered to their terminals to make connection for applying the load. Resistors shall be so arranged that the temperature of any one resistor will not appreciably influence the temperature of any other resistor. There shall be no undue draft over the resistors. The voltage used shall be the rated continuous working voltage from an ac supply at commercial-line frequency and waveform (see 3.6), and adequate precaution shall be taken to maintain constant voltage on resistors under test.

**4.6.13.2 Procedure.** Following a measurement of maximum engageable resistance (see 4.6.1.2), the voltage shall be applied intermittently,  $1\frac{1}{2}$  hours on and  $\frac{1}{2}$  hour off, for a total of  $1,000 \pm 12$  hours. This voltage shall be applied to the terminals specified in 4.6.1.2. Resistance measurements (see 4.6.1.2) shall be made at the end of the  $\frac{1}{2}$ -hour off periods after  $50 \pm 4$ ,  $100 \pm 8$ ,  $250 \pm 12$ ,  $500 \pm 12$ ,  $750 \pm 12$ , and  $1,000 \pm 12$  hours have elapsed. Resistors shall then be examined for evidence of mechanical damage.

## 5. PREPARATION FOR DELIVERY

**5.1 Preservation and packaging (see 6.1).**

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**5.1.1 Level A.** Unless otherwise specified (see 6.1), resistors shall be individually protected and unit-packaged in accordance with method 1A of Specification MIL-P-116, without the use of contact preservatives. Unless otherwise specified (see 6.1), unit packages less than 12 cubic inches in size shall be further packaged, in quantities of five or a multiple thereof, in intermediate containers conforming to Specification PPP-B-566, PPP-B-665, or PPP-B-676. The gross weight of the intermediate container shall not exceed 10 pounds.

**5.1.1.1 Bracket assembly.** Bracket assembly, if required, shall be enclosed in a drawstring-type cloth bag and inserted in the unit package with each resistor.

**5.1.2 Level C.** Resistors shall be afforded preservation and packaging in accordance with the manufacturer's normal commercial practice.

### 5.2 Packing (see 6.1).

**5.2.1 Level A.** Resistors packaged as specified (see 6.1) shall be packed in overseas-type wirebound wood, wood-cleated fiberboard, wood-cleated plywood, nailed wood, fiber (class 2 or 3, as specified (see 6.1)), or woodcleated paper-overlaid boxes conforming to Specifications PPP-B-585, PPP-B-591, PPP-B-601, PPP-B-621, PPP-B-636, and MIL-B-10377, respectively, at the option of the supplier. Shipping containers shall have case liners conforming to Specification MIL-L-10547; the case liners shall be closed and sealed in accordance with the appendix thereto. Case liners for boxes conforming to Specification PPP-B-636 may be omitted provided the center and edge seams and manufacturers' joints are sealed with tape, at least 1½ inches wide, conforming to Specification PPP-T-76. Box closures and strapping shall be as specified in the applicable box specification or appendix thereto. Fiber boxes conforming to Specification PPP-B-636 may be banded with tape conforming to type IV of Specification PPP-T-

97 and appendix thereto in lieu of steel straps. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

**5.2.2 Level B.** Resistors packaged as specified (see 6.1) shall be packed in domestic-type wirebound wood, wood-cleated fiberboard, wood-cleated plywood, nailed wood, fiber (class 1 or 2, as specified (see 6.1)), or wood-cleated paper-overlaid boxes conforming to Specifications PPP-B-585, PPP-B-591, PPP-B-601, PPP-B-621, PPP-B-636, and MIL-B-10377, respectively, at the option of the supplier. Box closures shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

**5.2.3 Level C.** Resistors packaged as specified (see 6.1) shall be packed in containers of the type, size, and kind commonly used for the purpose, in a manner that will insure acceptance by common carrier and safe delivery at destination. Shipping containers shall comply with the Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

**5.2.4 General.** Insofar as possible and practicable, exterior containers shall be uniform in shape and size, shall be of minimum cube and tare consistent with the protection required, and shall contain identical quantities of identical items.

**5.3 Marking.** In addition to any special marking required by the contract or order, unit packages, intermediate packages, and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129. (See 6.1.)

## 6. NOTES

**6.1 Ordering data.** Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) The complete type designation. (See 1.2.1).
- (c) Levels of preservation and packaging and packing, and applicable marking. (See sect. 5).
- (d) Number of unit packages if other than that specified in 5.1.1.
- (e) Class of fiber. (See 5.2.1).
- (f) Whether bracket assembly is required. (See 6.7.1).

**6.2 Qualification.** With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is Signal Corps; however, information pertaining to qualification of products may be obtained from the Armed Services Electro-Standards Agency (ASESA), Fort Monmouth, N. J.

**6.3 Government verification inspection.** Verification inspection by the Government will be limited to the amount deemed necessary to determine compliance with the contract or order, and will be limited in severity to the definitive quality assurance provisions established in this specification and the contract or order. The amount of verification inspection by the Government will be adjusted to make maximum utilization of the

supplier's quality control system and the quality history of the product. (See 4.1.2).

**6.4 Power dissipation.** Resistors are rated in accordance with 4.6.7. When higher ambient temperatures exist or when resistors are mounted in enclosures which limit ventilation, the wattage dissipation of any resistor should be reduced in accordance with figure 1, so that the maximum continuous operating temperature permissible for the resistor is never exceeded under the most severe combination of temperature conditions. (See 6.8).

**6.5 Spacing.** When resistors are mounted in rows or banks, they should be so spaced that, taking into consideration the restricted ventilation and heat dissipation of the nearby resistors, none of the resistors in the bank or row 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.

**6.6 Supplementary insulation.** When voltages greater than 500 volts dc, or 350 volts ac rms, are present between resistor circuits and grounded surfaces on which resistors are mounted, supplementary insulation capable of withstanding the voltage condition should be provided between resistors and mountings or between mountings and ground.

**6.7 Mounting.** Resistors should not be mounted by their terminals.

**6.7.1 Bracket assemblies.** When required (see 6.1), bracket assemblies (mounting hardware) are available for these resistors under Standard MS75009, "Bracket Assembly, Resistor (Power Type)."

**6.8 Choice of styles.** The styles of 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

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be applicable under the most severe combination of conditions, i.e., with the equipment operating 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); and
- (f) At high altitude.

**6.9 Soldering.** When operated at full load, the maximum temperature may be 350°C. The solder used for connecting leads to the terminals should be chosen accordingly.

**6.10 High frequency.** Resistors should not be used in circuits where their ac perform-

ance is of critical importance in the operation of such circuits.

**6.11 Adjustments.** Lugs should always be loosened completely before moving and should not be moved except while the voltage is off, in order to protect the operator from dangerous voltages. When adjusted to the position desired, the adjustable terminal should be tightened sufficiently to assure good electrical contact.

**Notice.** When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

**Custodians:**

Army—Signal Corps  
Navy—Bureau of Ships  
Air Force

**Preparing activity:**

Army—Signal Corps

## APPENDIX

### PROCEDURE FOR QUALIFICATION INSPECTION

#### 10. SCOPE

10.1 This appendix details the procedure for submission of samples, with related data, for qualification inspection of resistors covered by this specification. The procedure for extending qualification of the required sample to other resistors covered by this specification is also outlined herein.

#### 20. SUBMISSION

20.1 **Sample.** A sample consisting of 12 coated or enclosed sample units, of the styles specified in column 1 of table VIII of the highest resistance value and using a nominal diameter wire of 0.004 inch, shall be submitted for each style for which qualification is sought. If the same coating and material are not used, a separate submission shall be furnished for each coating and material for which qualification is sought. Four uncoated or unenclosed sample units shall also be submitted in each style specified in column 1 of table VIII. If enclosures are used in lieu of coatings, four enclosures shall also be furnished. Sample units shall be submitted complete with supplementary insulation and mounting hardware normally used for mounting the resistors. The submitted samples shall be representative of the supplier's normal production.

20.2 **Test data.** Each submission shall be accompanied by test data covering the non-

destructive tests listed in table II which have been performed on the submitted sample units. The performance of the destructive tests by the supplier on a duplicate set of sample units is encouraged, although not required. All test data shall be submitted in duplicate.

20.3 **Description of items.** The supplier shall submit a detailed description of the resistors being submitted for inspection, including wire used for the resistance element, the type of coating or enclosure, and the material used for the terminals.

#### 30. EXTENT OF QUALIFICATION

30.1 Qualification of a particular style and resistance value will qualify a range of resistance values from the smallest value listed in the style (see 3.1) to the resistance value tested. In addition, qualification of one style will be the basis for qualification of another style (or styles), as specified in table VIII.

TABLE VIII. *Style qualification*

Style submitted	Styles qualified
RX29 .....	RX29
RX32 .....	RX29 and RX32
RX33 .....	RX29, RX32, and RX33
RX35 .....	RX29, RX32, RX33, and RX35
RX36 .....	RX36
RX37 .....	RX36 and RX37
RX38 .....	RX36, RX37, and RX38
RX47 .....	RX36, RX37, RX38, and RX47

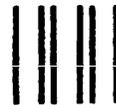
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b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR	
		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> OTHER (Specify): _____	
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	