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## PERFORMANCE SPECIFICATION

### RESISTOR, VARIABLE, WIRE WOUND, PRECISION GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments  
and Agencies of the Department of Defense.

#### 1. SCOPE

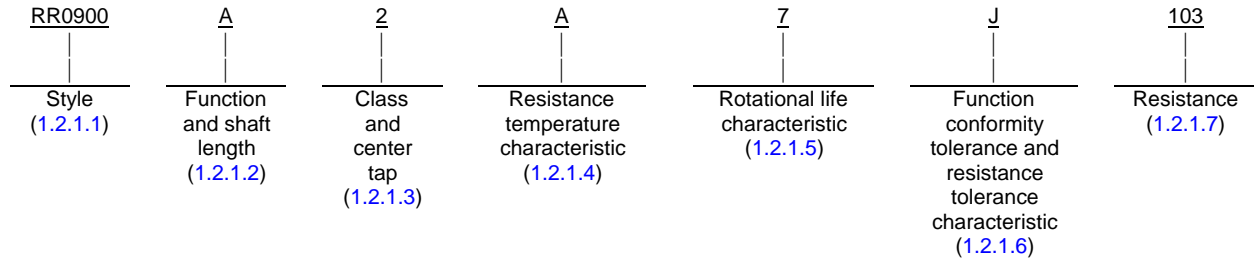
1.1 Scope This specification covers the general requirements for precision, wire-wound, variable resistors whose electrical output (in terms of percent of applied voltage) are linear or nonlinear with respects to the angular position of the shaft. This specification includes requirements for linear and nonlinear, single turn and multiturn, single-section (cup) and multisection variable resistors. These resistors are capable of full-load operation at maximum ambient temperatures of 70°C and 85°C and are suitable for continuous operation, when properly derated, to maximum temperatures of 125°C and 150°C (see 3.1, 6.2, and figure 10). This specification includes requirements for category I, category II, and category III precision resistors as described herein (see 3.2).

#### 1.2 Classification:

##### 1.2.1 Part or Identifying Number (PIN).

- a. Category I resistors: The PIN completely describes the category I resistors of this specification.

#### Single-section (cup) resistors



- b. Category II resistors: The PIN of 1.2.1 is modified by changes in style designation (see 1.2.1.1), when used to describe a category II resistor. The PIN in this case does not fully describe the individual resistor. The resistor in this case is completely identified only by the addition of a drawing number in the marking (see 3.34 and 6.2.2).

RR09XXA2A7J103

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAT, Post Office Box 3990, Columbus, Ohio 43216-5000 or by email [Resistor@dia.mil](mailto:Resistor@dia.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://www.dodssp.daps.mil>.

- c. Multisectioned (ganged) resistors (category III): For multisectioned (ganged) resistors, the PIN includes the PIN for each section (cup), preceded by a digit denoting the number of sections (cups) in the gang, as indicated in the following example:

3RR09XXA2A7J103  
 3RR09XXA2A7J104      ganged (three cups)  
 3RR09XXA2A7J103

The PIN is listed in the order in which the sections (cups) are stacked (ganged), beginning with the section (cup) nearest the mounting surface.

1.2.1.1 Style. The style is identified by the two-letter symbol "RR" followed by a four-digit number. The letters "RR" identify precision, variable, wire-wound resistors. The first two digits in the number identifies physical size, the last two digits identifies a category I or category II resistor. The digits for a category I resistor should be "00". The digits for a category II resistor will be "XX". Example:

RR0900 - Category I resistor  
 RR09XX - Category II resistor

The category III item is not identified by a single number, but is described in the user's drawing.

1.2.1.2 Function and shaft length. The type of function and shaft length are identified in accordance with table I (see 3.1).

TABLE I. Function and shaft length.

Symbol	Length <u>1/</u> <u>2/</u>			Function
	Servo mounted	Bushing mounted (single turn)	Bushing mounted (multi-turn)	
	<u>Inches</u> (± 0.031)	<u>Inches</u> (± 0.031)	<u>Inches</u> (± 0.031)	
A	0.375 (9.53)	0.750 (19.05)		Linear
B	0.500 (12.70)	0.875 (22.23)		Linear
C	0.625 (15.88)	1.000 (25.40)	0.625 (15.88)	Linear
D	0.750 (19.05)	1.125 (28.58)	0.750 (19.05)	Linear
E	0.875 (22.23)	1.250 (31.75)	0.875 (22.23)	Linear
F	1.000 (25.40)	1.375 (34.93)	1.000 (25.40)	Linear
X	As specified	As specified	As specified	As specified

1/ Length of shaft from mounting surface of resistor, nominal.

2/ Metric equivalents are in parentheses.

1.2.1.3 Class and center tap. The class and center tap is identified by a single digit in accordance with table II and as specified (see 3.1).

TABLE II. Class and center tap.

Symbol	Class 1		Center tap <u>1/</u>
	Maximum ambient temperature at rated wattage	Maximum ambient operating temperature	Tap located at center of resistive element ( $\pm 1$ degree)
	$^{\circ}\text{C}$	$^{\circ}\text{C}$	
2	70	125	Not applicable
3	85	150	Not applicable
4	70	125	Applicable
5	85	150	Applicable
X	As specified	As specified	As specified

1/ Applicable only to linear function resistors.

1.2.1.4 Resistance temperature characteristic. The resistance temperature characteristic of the completed resistor is identified by a single letter in accordance with table III.

TABLE III. Resistance temperature characteristic.

Symbol	Resistance-temperature characteristic in percent per $^{\circ}\text{C}$ <u>1/</u>
A	$\pm 0.003$
B	$\pm 0.005$
C	$\pm 0.010$
D	$\pm 0.016$
E	$\pm 0.026$
F	$\pm 0.040$
G	$\pm 0.070$
H	$\pm 0.100+$
X	As specified

1/ Referred to an ambient temperature at  $25^{\circ}\text{C}$ .

1.2.1.5 Rotational life characteristic. The rotational life characteristic is identified by a single digit in accordance with table IV ([see 3.1](#)).

TABLE IV. Rotational life characteristic.

Symbol	Rotational life (cycles) <u>1/</u> <u>2/</u> <u>3/</u>			
	Single turn	3 turn	5 turn	10 turn
7	125,000	85,000	50,000	25,000
8	250,000	175,000	100,000	50,000
9	500,000	350,000	200,000	100,000
X	As specified	As specified	As specified	As specified

1/ A cycle consists of travel through 95 percent of actual electrical travel and return to starting point.

2/ For qualification only.

3/ Minimum number of cycles required.

1.2.1.6 Function conformity tolerance and resistance tolerance characteristic. The function conformity tolerance and resistance tolerance characteristic is identified by a single letter in accordance with table V (see 3.1).

TABLE V. Function-conformity-tolerance and resistance tolerance characteristic.

Symbol	Function-conformity tolerance	Resistance tolerance <u>1/</u>	Symbol	Function-conformity tolerance	Resistance tolerance <u>1/</u>
	<u>Percent</u> ±	<u>Percent</u> ±		<u>Percent</u> ±	<u>Percent</u> ±
A	1.000	5	M	1.000	2
B	0.500	5	N	0.500	2
C	0.250	5	O	0.250	2
D	0.100	5	P	0.100	2
E	0.050	5	Q	0.050	2
F	0.025	5	R	0.025	2
G	1.000	3	S	1.000	1
H	0.500	3	T	0.500	1
I	0.250	3	U	0.250	1
J	0.100	3	V	0.100	1
K	0.050	3	W	0.050	1
L	0.025	3	Y	0.025	1
			X	As specified	As specified

1/ The preferred resistance tolerances are 1 and 3 percent.

1.2.1.7 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. When fractional values of an ohm, or 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 succeeding digits of the group represent significant figures, as shown in the following example"

3R0 signifies 3.0 ohms

1.2.1.8 Example of PIN (category I resistor). The PIN RR0900A2A7J103 signifies:

- RR0900 - Precision, wire-wound, variable resistor (single-turn) of the dimensions specified (see 3.1).
- A - Linear function and 0.375 inch (9.53 mm) shaft length.
- 2 - Resistance to moisture, and capable of rated-wattage operation at 70°C maximum, and when derated, at 125°C maximum (see figure 10).
- A - Resistance temperature characteristic of ±0.003 percent per °C.
- 7 - Capable of 125,000 cycles of rotational life.
- J - Function conformity tolerance of ±0.10 percent and resistance tolerance of ±3 percent.
- 103 - Nominal total resistance value of 10,000 ohms.

1.2.1.9 Example of PIN (category II resistor). The PIN RR09XXA2A7J103 signifies:

- RR09XX - Precision, wire-wound, variable resistor (single-turn) with requirements as specified on acquisition document.
- A - Linear function and 0.375 inch (9.53 mm) shaft length.
- 2 - Resistance to moisture, and capable of rated-wattage operation at 70°C maximum, and when derated, at 125°C maximum (see figure 10).
- X - Resistance temperature characteristic of ±0.003 percent per °C.
- 7 - Capable of 125,000 cycles of rotational life.
- J - Function conformity tolerance of ±0.10 percent and resistance tolerance of ±3 percent.
- 103 - Nominal total resistance value of 10,000 ohms.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

### 2.2 Government documents.

2.2.1 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 cited in the solicitation or contract ([see 6.2](#)).

#### DEPARTMENT OF DEFENSE SPECIFICATION

(See supplement 1 for list of specification sheets.)

#### DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-202](#) - Test Methods Standard Electronics and Electrical Components Parts.  
[MIL-STD-810](#) - Environmental Engineering Considerations and Laboratory Tests.  
[MIL-STD-1285](#) - Marking of Electrical and Electronic Parts.

#### DEPARTMENT OF DEFENSE HANDBOOKS

[FED-STD-H28](#) - Screw Thread Standards for Federal Services.

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://www.dodssp.daps.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094).

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents cited in the solicitation or contract ([see 6.2](#)).

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

[ANSI/NCSL Z540-1](#) - Laboratories, Calibration, and Measuring and Test Equipment.

#### INTERNATIONAL ORGANIZATION for STANDARDS (ISO)

[ISO 10012-1](#) - Equipment, Quality Assurance Requirements for Measuring - Part 1: Meteorological Confirmation System for Measuring Equipment.

(Applications for copies are available online at <http://www.ansi.org/> or should be addressed to the American National Standards Institute, 11 West 42nd Street New York, NY 10036.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In 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. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Resistor categories. Resistors furnished under this specification shall be category I, category II, or category III, as defined herein.

3.2.1 Category I resistor. A part that meets all requirements specified on a given specification without any exception, can be completely described by a PIN, (see 1.2.1) is covered by the family of products on the Qualified Products List (QPL), and is produced on an approved production line. Acquisition of these resistors shall be confined to sources whose family of products are listed on the QPL.

3.2.2 Category II resistor. A category II resistor is a part which is covered by the scope of a family of products qualification on an approved production line, but which differs from the category I item within the limits of similarity defined in 4.5.3. Acquisition of these resistors shall be confined to sources whose family of products are listed on the QPL.

3.2.3 Category III resistor. These resistors are of such a design, material, or construction that they can not be considered to fall within the scope of qualification (see 6.2.3).

3.3 Qualification. Resistors furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.4 and 6.3).

3.4 Materials. Materials 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.

3.4.1 Fungus. All external materials shall be nonnutrient to fungus growth or shall be suitably treated to retard fungus growth. The manufacturers shall certify that all external materials are fungus resistant or shall perform the test specified in 4.7.28. There shall be no evidence of fungus growth on the external surface as a result of the test.

3.5 Interface and physical dimensions The resistors shall meet the interface and physical dimensions specified (see 3.1).

3.5.1 Operating shaft. All operating shafts shall be corrosion resistant.

3.5.1.1 Style. Unless otherwise specified, standard operating shafts shall be round (see 3.1 and 6.2).

3.5.1.2 Length. Unless otherwise specified, the lengths of standard operating shafts shall be in accordance with table I (see 3.1 and 6.2).

3.5.2 Contact arm assembly. Contact pressure on the resistance element shall be maintained by uniform positive pressure and shall permit smooth electrical and mechanical control of the resistor over the entire range of continuity travel (applicable to resistors with stops). The moving contact shall have continuous electrical contact with its terminal throughout the entire mechanical travel and shall be insulated from the operating shaft, bushing, and case.

3.5.3 Stops. Stops employed to limit the mechanical travel of the contact arm assembly may be part of, but shall not complete, any electrical circuit. In no case shall the mechanical stop contact the electrical pick off portion of the contact assembly.

3.5.4 Detachable sections. When detachable individual sections are used, their shaft extensions and contact arm shall be firmly coupled when ganged, but shall be capable of being detached without incurring either electrical or mechanical damage to the ganged assembly.

3.5.5 Phasing. Unless otherwise specified (see 3.1 and 6.2), the alignment of the functional angles of the individual cups of a ganged assembly shall be performed by the manufacturer, at the time of assembly so that the voltage ratios of all cups of the assembly fall within their respective specified functional characteristics at any angle of operating shaft rotation.

3.5.6 Terminals. Terminals shall be located as shown in the associated specification sheets, (see 3.1 and 6.2). The terminals shall be suitably treated to facilitate soldering.

3.5.6.1 Designations. Terminals shall be numbered with number 2 as the contact arm terminal, number 1 as the counterclockwise terminal, and number 3 as the clockwise terminal. Taps shall be numbered in sequence with terminal number 4 nearest the counterclockwise end (see figure 1).

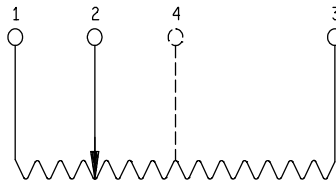


FIGURE 1. Circuit diagram.

3.5.7 Threaded parts. All external threaded parts shall be in accordance with FED-STD-H28, and as specified herein.

3.5.8 Hardware (for bushing mounted units). Each resistor shall be furnished with a corrosion resistant, internal tooth lock washer and a hexagonal mounting nut. Unless otherwise specified, the hardware shall be assembled on the resistor (see 3.1).

3.5.9 Enclosure. Resistors shall have suitable enclosures for protection against mechanical damage and shall be dustproof.

3.6 Lateral runout. When resistors are tested as specified in 4.7.2, the lateral runout shall not exceed 0.002 inch per inch (0.05 mm) of mounting surface radius or 0.001 inch (0.03 mm), whichever is greater.

3.7 Shaft runout. When resistors are tested as specified in 4.7.3, the shaft runout shall not exceed 0.002 inch per inch (0.05 mm) of shaft length, from mounting surface to point of measurement or 0.001 inch (0.03 mm) total, whichever is greater.

3.8 Pilot surface runout. When resistors are tested as specified in 4.7.4, the pilot surface runout shall not exceed 0.001 inch (0.05 mm).

3.9 Radial play. When resistors are tested as specified in 4.7.5, the radial play shall not exceed 0.002 inch (0.05 mm).

3.10 End play. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.6, the end play shall not exceed 0.005 inch (0.13 mm).

3.11 Mechanical travel (applicable to resistors with stops). When resistors are tested as specified in 4.7.7, the mechanical travel shall be as specified (see 3.1 and 6.2).

3.12 Torque (see 4.7.8).

3.12.1 Starting (see 4.7.8.1).

3.12.1.1 Initial. Unless otherwise specified (see 6.2), the maximum torque required to initiate rotation of the contact arm shall be as specified (see 3.1).

3.12.1.2 Running. Unless otherwise specified (see 4.7.8.2 and 6.2), the maximum running torque shall be as specified (see 3.1).

3.12.2 Degradation. The torque required to initiate or sustain rotation of the contact arm shall not increase more than 50 percent of the initial specified value (see 3.1).

3.12.3 Stop (when applicable). When resistors are tested as specified in 4.7.8.3, there shall be no mechanical damage to the contact arm and stop, and the total mechanical travel shall not increase by more than 1 degree.

3.13 Power rating. The resistors shall have power rating based on a continuous full load operation at the ambient temperature specified for the applicable characteristic (see 3.1 and table II). Power ratings as specified (see 3.1) are applicable only when the maximum resistance is engaged in the circuit. When only a portion of the resistance element is engaged in the circuit, the power rating is reduced in approximately the same proportion as the resistance.

3.14 Voltage rating. The theoretical calculated rated continuous working voltage or the voltage equivalent to power rating (rated wattage) shall be determined from the following formula:

$$E = \sqrt{PR}$$

Where:

- E = Rated dc or root mean square (rms) continuous working voltage.
- P = Power rating.
- R = Nominal total resistance.

The rated voltage shall not exceed the maximum continuous working voltage (see 3.1).

3.15 DC resistance (see 4.7.9).

3.15.1 Total.

3.15.1.1 Initial resistance. When measured as specified in 4.7.9.1, the total direct current (dc) resistance shall not deviate from the specified nominal resistance value by more than plus or minus the resistance tolerance (see 3.1 and 6.2).

3.15.2 Absolute minimum resistance. Unless otherwise specified (see 3.1 and 6.2), when measured as specified in 4.7.9.2, the absolute minimum resistance shall not exceed 1 percent of the nominal total resistance value or 5 ohms, whichever is greater.

3.16 End voltage. Unless otherwise specified (see 3.1 and 6.2), when measured as specified in 4.7.10, the end voltage shall not be more than 0.5 percent of the total applied voltage.

3.17 Taps (when applicable). When resistors are tested as specified in 4.7.11, taps shall be located as specified (see table II, 3.1, and 6.2).

3.18 Insulation resistance.

3.18.1 Initial. When resistors are tested as specified in 4.7.12, the insulation resistance shall not be less than 1,000 megohms.

3.18.2 Degradation. When resistors are tested as specified 4.7.12, the insulation resistance shall not be less than 100 megohms.



3.19 Dielectric withstanding voltage. When resistors are tested as specified in 4.7.13, there shall be no damage, arcing, or breakdown. The leakage current shall not exceed 1 milliampere (mA).

3.20 Function conformity tolerance.

3.20.1 Initial. When resistors are tested as specified in 4.7.14, the function conformity tolerance shall be as specified (see table V and 3.1). The actual effective electrical travel shall be as specified (see 3.1 and 6.2).

3.20.2 Degradation. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.14, the function conformity tolerance shall be not more than 150 percent of the value specified in 3.20.1.

3.21 Peak noise.

3.21.1 Initial. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.15, the peak noise resistance shall not exceed 100 ohms.

3.21.2 Degradation. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.15, the peak noise resistance shall not exceed 500 ohms.

3.22 Mechanical backlash. When resistors are tested as specified in 4.7.16, the operating shaft shall not move in excess of the applicable value specified in table VI, or the specified value (see 3.1 and 6.2), without moving the contact arm.

TABLE VI. Mechanical backlash.

Mechanical backlash (angular degrees)					
Function conformity tolerance %	Single turn	3 turn	5 turn	10 turns	
				RR1000 RR4000	RR1400 RR2100 RR4100
1.000	0.50	0.50	1.00	1.50	1.00
0.500	0.25	0.50	1.00	1.50	1.00
0.250	0.10	0.50	1.00	1.50	1.00
0.100	0.10	0.10	0.50	1.00	0.50
0.050	0.10	0.10	0.50	1.00	0.50
0.025	0.10	0.10	0.50	0.50	0.25

3.23 Terminal strength. When resistors are tested as specified in 4.7.17, there shall be no evidence of mechanical damage.

3.24 Thermal shock. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.18, there shall be no evidence of mechanical damage, and the total resistance change shall not exceed 5 percent of the initial resistance value (see 3.15.1).

3.25 Resistance temperature characteristic. When resistors are tested as specified in 4.7.19, the resistance temperature characteristic, referred to an ambient temperature of 25°C, shall be within the limits of the values specified in table III, or as specified (see 3.1 and 6.2).

3.26 Rotational load life. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.20, there shall be no evidence of mechanical damage or opening of the winding, and the total resistance change shall not exceed 5 percent between the initial resistance value (see 3.15.1.1), measured at the rated ambient temperature previous to the rotational load life test, and any of the succeeding measurements.

3.27 Low temperature operation. When resistors are tested as specified in 4.7.21, electrical and mechanical connections shall not be adversely affected. Unless otherwise specified (see 3.1 and 6.2), the torque required to effect rotation shall not exceed two times the specified torque (see 3.1), and the total resistance change shall not exceed 5 percent of the initial resistance value (see 3.15.1.1).

3.28 Low temperature exposure. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.22, there shall be no evidence of mechanical damage, and the total resistance change shall not exceed 5 percent of the initial resistance value (see 3.15.1.1).

3.29 High temperature exposure. When resistors are tested as specified 4.7.23, there shall be no evidence of mechanical damage, and the total resistance change shall not exceed 5 percent of the initial resistance value (see 3.1 and 6.2).

3.30 Shock, specified pulse. When resistors are tested as specified in 4.7.24, there shall be no evidence of mechanical or electrical damage, or momentary discontinuity.

3.31 Vibration, high frequency. When resistors are tested as specified in 4.7.25, there shall be no evidence of mechanical or electrical damage, or momentary discontinuity. The total resistance change shall not exceed 5 percent of the initial resistance value (see 3.15.1.1)

3.32 Salt spray (corrosion). When resistors are tested as specified 4.7.26, there shall be no appreciable corrosion.

3.33 Moisture resistance. Unless otherwise specified (see 3.1 and 6.2), when resistors are tested as specified in 4.7.27, the insulation resistance shall not be less than 10 megohms, and the total resistance shall not exceed 3 percent of the initial resistance value (see 3.15.1.1).

3.34 Marking. Resistors shall be marked with the following minimum information:

- a. PIN (see 1.2.1) category I resistor.
- b. Acquisition drawing number. Category II and III (on category II items, the original equipment manufacturer's drawing number shall be marked on the unit and the specification style number shall be marked on the units, the specification style number shall also be shown in the drawing (see 1.2.1b).
- c. Manufacturer's name, Commercial and Government Entity (CAGE) code symbol or trade mark.
- d. Manufacturer's part number.
- e. Terminal identification shall be marked in accordance with 3.5.6.1.
- f. Date code in accordance with MIL-STD-1285. When the date code does not provide specific production lot identification, the resistor shall be marked with a code symbol in accordance with MIL-STD-1285.

All markings shall be visible on the cylindrical surface of the resistor. There shall be no space between symbols which comprise the PIN. Each resistor of a multisection (ganged) units shall be similarity marked. All markings shall remain legible at the end of all tests.

3.35 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.36 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

#### 4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Retention of qualification (see 4.5).
- c. Conformance inspection (see 4.6).

4.2 Test equipment and inspection facilities. The manufacturer shall establish and maintain a calibration system in accordance with ANSI/NCSL Z540-1, ISO 10012-1, or equivalent system as approved by the qualifying activity.

4.3 Inspection conditions and precautions.

4.3.1 Inspection conditions. Unless otherwise specified herein, all inspections shall be in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.3.2 Precautions. Adequate precautions shall be taken during inspection to prevent condensation of moisture on resistors. Precautions shall also be taken to prevent damage by heat when soldering resistor leads to terminals. The theoretically calculated continuous working voltage or the voltage equivalent to power rating (rated wattage) shall be determined from the following formula:

$$E = \sqrt{PR}$$

Where:

- E = Rated dc or root-mean-square (rms) ac continuous working voltage at commercial-line frequency and waveform.
- P = Power rating.
- R = Nominal total resistance.

In no case shall the rated voltage exceed the maximum continuous working voltage specified (see 3.1). Adequate precautions shall be taken during tests to prevent condensation of moisture on resistors except during the moisture-resistance and temperature-cycling tests.

4.4 Qualification. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.

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

4.4.2 Inspection routine (category I resistors). Sample units shall be subjected to the qualification inspection specified in table VII, in the order shown. Eighteen sample units shall be subjected to the inspection of group I. An additional sample unit shall be subjected to the inspection of group II and if applicable, two additional units shall be subjected to group VII. After the inspection of group I, the 18 sample units shall then be divided as specified in table VII for groups III to VI inclusive. The sample units shall then be subjected to the inspection for their particular group.

When servo mount types are submitted for qualification, and qualification is desired for bushing mounted units of the same physical size and construction (except for faceplate), three additional sample units with bushing mounts shall be submitted to inspection of group I of table VII. In a like manner, three additional sample units with servo mounts shall be subjected to group I of table VII, when bushing types are submitted for qualification. Extension of qualification from one case and winding from material to a different material will require complete qualification inspection.

4.4.3 Defective. Failure of a resistor in one or more tests of a group shall be charged as a single failure. No failures shall be allowed for groups I, II, and VII. One failure shall be allowed for groups III, IV, V, and VI combined. Failures in excess of those allowed shall be cause for refusal to grant qualification.

TABLE VII. Qualification inspection.

Inspection <u>1/</u>	Requirement paragraph	Method paragraph	Number of samples	Number of defectives
<u>Group I</u>				
Visual and mechanical examination <u>2/ 3/</u>	3.1, 3.4 to 3.5.9 inclusive and 3.34 to 3.36 inclusive	4.7.1	18	0
Lateral runout <u>3/</u>	3.6	4.7.2		
Shaft runout <u>3/</u>	3.7	4.7.3		
Pilot surface runout <u>3/</u>	3.8	4.7.4		
Radial play <u>3/</u>	3.9	4.7.5		
End play <u>3/</u>	3.10	4.7.6		
Mechanical travel (applicable to resistors with stops) <u>3/</u>	3.11	4.7.7		
Torque <u>3/</u>	3.12	4.7.8		
Total resistance <u>3/</u>	3.15.1	4.7.9.1		
Absolute minimum resistance <u>3/</u>	3.15.2	4.7.9.2		
End voltage <u>3/</u>	3.16	4.7.10		
Taps (when applicable) <u>3/</u>	3.17	4.7.11		
Insulation resistance <u>3/</u>	3.18	4.7.12		
Dielectric withstanding voltage <u>3/</u>	3.19	4.7.13		
Functional conformity tolerance <u>3/</u>	3.20	4.7.14		
Peak noise <u>3/</u>	3.21	4.7.15		
Mechanical backlash <u>3/</u>	3.22	4.7.16		
Terminal strength	3.23	4.7.17		
<u>Group II</u>				
Visual and mechanical examination	3.1, 3.4 to 3.4.1 inclusive, 3.5.2, 3.5.3, 3.5.9, 3.34 to 3.36 inclusive	4.7.1	1	0

See footnotes at end of table.

TABLE VII. Qualification inspection - Continued.

Inspection <u>1/</u>	Requirement paragraph	Method paragraph	Number of samples	Number of defectives
<u>Group III</u>				
Thermal shock <u>3/</u>	3.24	4.7.18	6	
Resistance temperature characteristic <u>3/</u>	3.25	4.7.19		
Rotational load life	3.26	4.7.20		
Functional conformity tolerance	3.20	4.7.14		
Peak noise	3.21	4.7.15		
Insulation resistance	3.18	4.7.12		
Dielectric withstanding voltage	3.19	4.7.13		
Torque	3.12	4.7.8		
<u>Group IV</u>				
Thermal shock	3.24	4.7.18	3	1
Low temperature operation	3.27	4.7.21		
Low temperature exposure	3.28	4.7.22		
Functional conformity tolerance	3.20	4.7.14		
Peak noise	3.21	4.7.15		
Torque	3.12	4.7.8		
High temperature exposure	3.29	4.7.23		
Functional conformity tolerance	3.20	4.7.14		
Peak noise	3.21	4.7.15		
Insulation resistance	3.18	4.7.12		
Dielectric withstanding voltage	3.19	4.7.13		
Torque	3.12	4.7.8		
<u>Group V</u>				
Thermal shock	3.24	4.7.18	3	
Shock (specified pulse)	3.30	4.7.24		
Vibration, high frequency	3.31	4.7.25		
Functional conformity tolerance	3.20	4.7.14		
Peak noise	3.21	4.7.15		
End play	3.10	4.7.6		
Torque	3.12	4.7.8		
Salt spray (corrosion)	3.32	4.7.26		
<u>Group VI</u>				
Thermal shock	3.24	4.7.18	6	
Moisture resistance	3.33	4.7.27		
Functional conformity tolerance <u>4/</u>	3.20	4.7.14		
Peak noise <u>4/</u>	3.21	4.7.15		
Torque <u>4/</u>	3.12	4.7.8		
<u>Group VII</u>				
Fungus	3.4.1	4.7.28	2	0

1/ The requirement for qualification inspection shall be those specified herein (and not those in the contract or order).

2/ Marking shall be considered defective only if the marking is illegible.

3/ Nondestructive tests.

4/ These tests shall be performed immediately following the moisture resistance tests.

4.5 Retention of qualification. Every 12 months, the manufacturer shall verify the retention of qualification to the qualifying activity. In addition, the manufacturer shall immediately notify the qualifying activity whenever the group B inspection results indicate failures of the qualified product to meet the requirements of this specification. Verification shall be based on meeting the following requirements:

- a. The manufacturer has not modified the design of the item.
- b. The specification requirements for the item have not been amended so far as to affect the character of the item.
- c. Lot rejection for group A inspection does not exceed the group A sampling plan.
- d. The requirements for group B inspection are met.

When group B requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, group B inspection retesting shall be instituted.

4.5.1 Category II resistors. The inspections applicable to category II resistors (in addition to the qualification of the associated family of products) shall be the groups A and B conformance tests specified herein (see 6.1), and any other additional conformance test specified in the acquisition document.

4.5.2 Category III resistors. All acquisition documents shall specify testing, which shall consist of requirements specified on the drawing and all tests listed in table VII. Requirements for these tests shall be modified as necessary in the acquisition document. Groups A and B conformance tests shall be specified in addition to any other tests considered necessary (see 6.1).

4.5.3 Scope of family of products qualification. Family of products qualification shall cover all resistors similar to the category I resistor which passed qualification requirements. Resistors meeting this criteria are designated as category II resistors. In order to be considered similar to the category I resistor, the category II resistor shall be within the following restrictions:

- a. The category II resistor shall have been produced on the same production line approved for the category I resistors.
- b. Material: All materials and finishes used in the manufacture of the category II resistor shall be the same as those used in the corresponding category I resistor submitted. This includes, but is not necessarily limited to, the materials used for the housing or case, shaft, mounting, construction, winding form, slip rings, rotors, or sliders. There shall be no restriction on the resistance wire or contact (wiper) materials provided the resistor meets all performance requirements. In all cases, the materials shall meet the requirements specified in 3.4.
- c. Interface and physical dimensions: The interface and physical dimensions of the category II resistor shall be the same as that of the corresponding category I resistor and shall meet the requirements of 3.5 to 3.5.9 inclusive. The only exceptions shall be tap and terminal design and construction which are unrestricted. Servo and bushing mounting interface and physical dimensions may vary, however, the basic interface and physical dimensions of the shaft bearing shall be similar to the category I resistor.
- d. External dimensions: The external dimensions of the housing or case of the category II resistor shall not deviate more than  $\pm 10$  percent of those of the corresponding category I resistor.
- e. Wattage rating: Category II resistors shall have wattage ratings equal to or less than that of corresponding category I resistors.
- f. Noise: Category II resistors shall have noise content the same or greater than the corresponding category I resistor.

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- g. Rotational load life: Category II resistors shall have rotational load life requirements equal to or less stringent than the corresponding category I resistor.
- h. Temperature rating: The maximum ambient and operating temperatures of the category II resistor shall not exceed those of the corresponding category I resistor.
- i. Multiturn: Category II resistors shall have the same nominal number of turns as the corresponding category I resistor.
- j. Multisection: Each section of a multisection resistor shall be considered separately and compared to, corresponding category I resistors to determine similarity. If each section meets this criteria, the entire multisection resistor shall be considered a category II resistor.
- k. The category II resistor may vary from the corresponding category I resistor without restriction in the following parameters for general requirements specified herein:
  - (1) Linearity and conformity.
  - (2) Actual electrical travel angle.
  - (3) Taps and tap location.
  - (4) Mechanical travel.
  - (5) Length, diameter, and configuration of operating shaft.
  - (6) Resistance and resistance tolerance.
  - (7) Absolute minimum resistance.
  - (8) Temperature coefficient.
  - (9) Running, starting, and stop torque.
  - (10) End play.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections.

4.6.1.1 Inspection lot. An inspection lot, as far as practicable, shall consist of all the resistors of the same style, or styles representing a group (see Appendix [table A-II](#)). The sample units shall be of the same class provided under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspections and tests specified in table VIII, and shall be made on the same set of sample units, in the order shown.

TABLE VIII. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	Sampling plan
Dimensions	3.1	4.7.1	See 4.6.1.2.1
Lateral runout	3.6	4.7.2	
Shaft runout	3.7	4.7.3	
Pilot surface runout	3.8	4.7.4	
Radial play	3.9	4.7.5	
End play	3.10	4.7.6	
Mechanical travel (applicable to resistors with stops)	3.11	4.7.7	
Torque	3.12	4.7.8	
Marking	3.34	4.7.1	
Workmanship	3.36	4.7.1	
Total resistance	3.15.1	4.7.9.1	
Absolute minimum resistance	3.15.2	4.7.9.2	
End voltage	3.16	4.7.10	
Taps (when applicable)	3.17	4.7.11	
Insulation resistance	3.18	4.7.12	
Dielectric withstanding voltage	3.19	4.7.13.1	
Function conformity tolerance	3.20	4.7.14	
Peak noise	3.21	4.7.15	
Mechanical backlash	3.22	4.7.16	

4.6.1.2.1 Sampling plan. A sample of parts from each inspection lot shall be randomly selected in accordance with table IX. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with table IX. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE IX. Sampling plan.

Lot size	Sample size
1 to 12	100 percent
13 to 150	13
151 to 280	20
281 to 500	29
501 to 1,200	34
1,201 to 3,200	42
3,201 to 10,000	50
10,001 to 35,000	60
35,001 to 150,000	74
150,001 to 500,000	90
500,001 to over	102

4.6.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table X, in the order shown. The inspection shall be performed on sample units which have been subjected to and passed group A inspection.

4.6.1.3.1 Sampling plan. Two sample units per lot shall be subjected to group B inspection with no failures permitted.

















































































