

PERFORMANCE SPECIFICATION

RESISTOR, VARIABLE, WIRE WOUND, NONPRECISION
GENERAL SPECIFICATION FOR

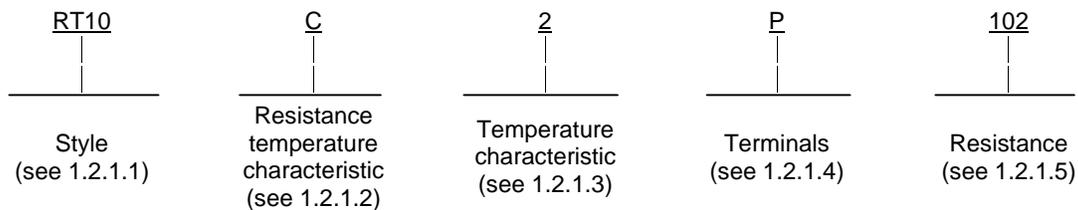
This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for multiturn, lead-screw actuated and single turn wire wound, variable resistors with a contact bearing uniformly over the entire surface of the entire resistive element, wound linearly, when positioned by an actuator. These resistors are capable of full load operation (where maximum resistance is engaged) at maximum ambient temperature of 85°C, and are suitable for continuous operation when properly derated, at a maximum temperature of 150°C (see figure 2). These resistors have a resistance tolerance of ±5 percent (see 3.1).

1.2 Classification.

1.2.1 Part or identifying number (PIN). The PIN is in the following form and as specified (see 3.1 and 6.2).



1.2.1.1 Style. The style is identified by the two letter symbol "RT" followed by a two digit number. The letters identify adjustment type, wirewound, variable resistors and the number identifies the physical size.

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

TABLE I. Resistance temperature characteristic.

Symbol	Maximum resistance temperature characteristic in percent/°C ^{1/}	Parts per million per °C (ppm/°C)
C	±0.005	±50

^{1/} Referred to an ambient temperature of 25°C.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, DSCC-VAT, Post Office Box 3990, Columbus, Oh 43216-5000 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

1.2.1.3 Temperature characteristic. The temperature characteristic is identified by a single digit number in accordance with table II.

TABLE II. Temperature characteristic.

Symbol	Maximum resistance temperature characteristic in percent/ ^o C	Parts per million per ^o C (ppm/ ^o C)
2	85 ^o C	150 ^o C

1.2.1.4 Terminals. The terminals are identified by a single letter in accordance with table III.

TABLE III. Terminals.

Symbol	Type of terminal
L	Flexible, insulated wire leads
P	Printed circuit pins
W <u>1/</u>	Printed circuit pins (edge mounted)
X <u>2/</u>	Printed circuit pins (edge mounted, alternative configuration)
Y <u>3/</u>	Printed circuit pins (staggered)

1/ Available only in essentially square styles. Pins extend from the edge 180^o away from the adjustment head and are parallel to the longitudinal axis of the adjustment screw.

2/ Available only in essentially square styles. Pins extend from the edge 90^o away from the adjustment head and are perpendicular to the longitudinal axis of the adjustment screw.

3/ Applicable only to style RT12.

1.2.1.5 Resistance. The nominal resistance value expressed in ohms is identified by a three digit number; the first two digits represent significant figures and the last digit specifies the number of zeros to follow. The following are examples of symbols for resistance values:

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

1.2.1.6 Example of PIN. The PIN RT10C2P102 signifies:

- RT10 - Adjustment type, wire wound, variable resistor of the dimensions specified (see 3.1).
- C - Having a resistance temperature characteristic of 0.005 percent (± 50 ppm) per ^oC.
- 2 - Having a temperature characteristic capable of operation at 85^oC maximum and derated, at 150^oC maximum (see 3.5).
- P - Having printed circuit pins.
- 102 - Having a nominal total resistance value of 1,000 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 they 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

- MIL-R-27208/4 - Resistors, Variable, Wire wound, Lead Screw Actuated, Trimmer, Style RT22. (INACTIVE FOR NEW DESIGN)
- MIL-PRF-27208/8 - Resistors, Variable, Wire wound, Lead Screw Actuated, Trimmer, Style RT12.
- MIL-PRF-27208/9 - Resistors, Variable, Wire wound, Lead Screw Actuated, Trimmer, Style RT24.
- MIL-PRF-27208/10 - Resistors, Variable, Wire wound, Lead Screw Actuated, Trimmer, Style RT26.
- MIL-PRF-39015 - Resistors, Variable, Wire wound (Lead Screw Actuated), Nonestablished Reliability, and Established Reliability, General Specification for.

STANDARDS

DEPARTMENT OF DEFENSE

- MIL-STD-202 - Test Methods for Standard Electronic and Electrical Component Parts.
- MIL-STD-810 - Environmental Engineering Considerations and Laboratory.
- MIL-STD-1276 - Leads for Electronic Components Parts.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Service, Building 4D (DPM-DODSSP), 700 Robbins Avenue, 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 that are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS (ANS)

- J-STD-006 - Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications.

(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.)

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 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 (except for related associated specifications, specification sheets, or MS sheets), 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 Associated specifications. The individual part requirements shall be as specified herein and in accordance with the applicable associated specifications. In the event of a conflict between requirements of this specification and the associated specifications, the latter shall govern (see 6.2).

3.2 Qualification. Resistors furnished under this specification shall be products that are qualified for listing on the applicable qualified product list (QPL) before contract award (see 4.4 and 6.3).

3.3 Materials. Materials 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.

3.3.1 Plastic. Plastic laminates containing a cotton fabric base or plastic molding compounds containing cotton or wood flour filler shall not be used. When not machined, plastic materials shall have smooth, or polished surfaces. Surfaces that have not been sawed, cut, punched, or otherwise machined shall be smooth as practicable in accordance with good manufacturing practice.

3.3.2 Ferrous metals. Unless specifically approved by the Government, the use of ferrous material, with the exception of corrosion resistance element material is prohibited.

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

3.4.1 Windings. The resistance element shall be wound on a suitable form that shall not char or break down as a result of the tests specified herein. The element shall be a continuous unbroken length of conductor without joints, or welds, except at the junction of the resistor element and winding terminals. The wire shall possess a uniform cross-sectional area and in no case shall the absolute minimum diameter be less than 0.0008 inch, unless otherwise specified (see 3.1).

3.4.2 Protective housing and enclosure. The resistance element of completed resistors shall be protected by a housing, or an enclosure, or both, which shall completely cover the exterior of the resistance element. The protective housing or enclosure shall be free from holes, fissures, chips, or other faults, and shall be such as to minimize the establishment of leakage paths between terminals, resulting from collection of moisture film on the exterior surface of the housing or enclosure. If the housing is made from aluminum alloy, it shall be properly protected against corrosion and all fasteners shall be suitably plated. Unplated copper alloy metals shall not be used in contact with aluminum.

3.4.3 Terminals. Terminals shall be as specified in table III. Connection of terminals to the resistance element shall be mechanically strong. All terminals shall be fastened securely. Terminals shall be suitably coated to meet the solderability requirements of 3.26 (see 6.11).

3.4.3.1 Terminal identification and circuit diagram.

3.4.3.1.1 Terminal identification.

3.4.3.1.1.1 Terminals P, W, X and Y. For terminals P, W, X, and Y type resistors, identification shall be by one of two methods. The numerals designating terminal identification may be marked adjacent to the terminals or the circuit diagram (see 3.4.3.1.2) may be used, provided that such identification clearly indicates the applicable terminals.

3.4.3.1.1.2 Terminal L. For terminal L type resistors, the insulation of the flexible lead shall be color coded as shown in figure 1.

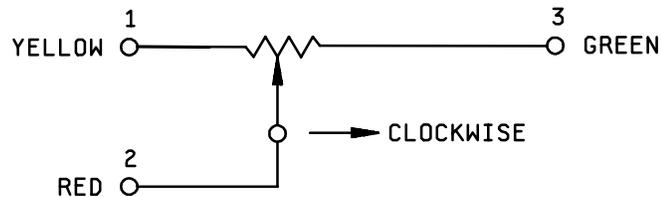


FIGURE 1. Circuit diagram

3.4.3.1.2 Circuit diagram. The circuit diagram shall be marked on any surface of the resistor in a legible manner, as shown on figure 1.

3.4.3.1.3 Legibility. Marking shall remain legible after all tests.

3.4.3.2 Solder dip (retinning) lead. The manufacturer may solder dip/retin the leads of the product supplied to this specification provided the solder dip process has been approved by the qualifying activity. See appendix.

3.4.4 Securing of screw thread assemblies. Screw thread assemblies shall not loosen as a result of the tests specified herein.

3.4.5 Operating shaft. The operating shafts shall be of corrosion resistant material with the head insulated from all electrical parts of the resistor. The operating shaft head shall be slotted as specified (see 3.1).

3.4.6 Contact arm assembly. Uniform contact pressure on the resistance element shall be maintained by positive pressure and shall permit smooth electrical and mechanical control of the resistor over the entire range. The moving contact shall have continuous electrical contact with its terminal throughout the entire mechanical travel and shall be insulated from the operating shaft head and case.

3.4.7 Mechanical limits.

3.4.7.1 Clutches (applicable only to multiturn lead screw actuated units, unless otherwise specified) (see 3.1). clutches shall be furnished to permit the contact arm to idle at either end of the resistance element without electrical or mechanical malfunctions (see 3.13.2).

3.4.7.2 Stops (applicable to single turn units, unless otherwise specified) (see 3.1). Stops employed to limit the mechanical rotation of the assembly are permitted to be part of, but shall not complete an electrical circuit.

3.5 Power rating. The resistors shall have a power rating based on continuous full load operation at the ambient temperature specified for the applicable characteristic (see 3.1 and table II). The power rating is dependent on the ability of the resistors to meet the life requirements specified in 3.21. For temperatures in excess of those specified, the load shall be derated as shown in figure 2. 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.

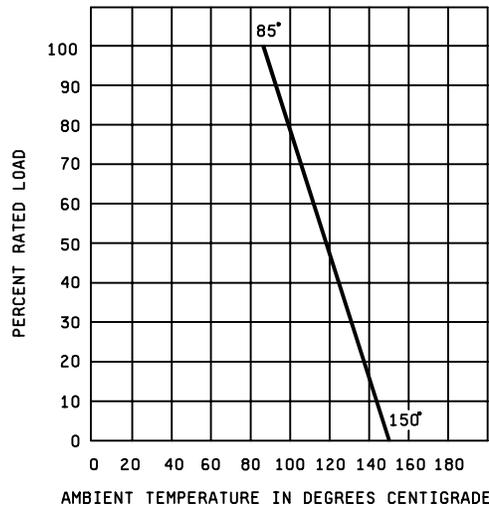


FIGURE 2. Derating curve for high ambient temperatures.

3.6 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).

3.7 DC resistance.

3.7.1 Total resistance. When measured as specified in 4.7.2.1, the total dc resistance shall not deviate from the specified nominal resistance (see 3.1) by more than ± 5 percent.

3.16 Moisture resistance. When tested as specified in 4.7.11, resistors shall meet the following requirements:

Total resistance:	Change shall not exceed $\pm(1$ percent +0.05 ohms).
Insulation resistance:	Shall be not less than 100 megohms.
Visual examination:	There shall be no evidence of mechanical damage.

3.17 Shock (specified pulse). When resistors are tested as specified in 4.7.12, the change in total resistance shall not exceed $\pm(1$ percent +0.05 ohms). The change in setting stability shall not exceed 1 percent plus the specified maximum resolution (see 3.1), and there shall be no electrical discontinuity or evidence of mechanical damage.

3.18 Vibration, high frequency. When resistors are tested as specified in 4.7.13, there shall be no electrical discontinuity, and resistors shall meet the following requirements.

Setting stability:	Change shall not exceed 1 percent plus the maximum specified resolution (see 3.1).
Total resistance:	Change shall not exceed $\pm(1$ percent +0.05 ohms).
Operating voltage:	Shall not exceed 150 percent of the specified operating torque (see 3.1).
Visual examination:	There shall be no evidence of mechanical damage.

3.19 Salt spray (corrosion). When resistors are tested as specified in 4.7.14, there shall be no appreciable corrosion.

3.20 Resistance to soldering heat (applicable to terminal type P,W,X, and Y only). When resistors are tested as specified in 4.7.5, the change in total resistance shall not exceed $\pm(1$ percent +0.05 ohms) and there shall be no evidence of mechanical failure.

3.21 Life. When tested as specified in 4.6.16, resistors shall meet the following requirements:

Resistance between end terminals, with the contact arm in the position for setting stability:	Change shall not exceed 2 percent plus the specified maximum resolution (see 3.1) between the initial measurements and each of the succeeding measurements.
Setting stability:	Change shall not exceed 2 percent plus the specified maximum resolution (see 3.1).
Total resistance	Change shall not exceed 2 percent.
Dielectric withstanding voltage at atmospheric pressure:	As specified in 3.11.
Operating torque	Shall not exceed 150 percent of the specified operating torque (see 3.1).
Visual examination:	There shall be no evidence of mechanical damage.

3.22 Low operating temperature. When resistors are tested as specified in 4.7.17, resistors shall meet the following requirements:

Setting stability	Change shall not exceed 1 percent plus the specified maximum resolution (see 3.1).
Operating torque	Shall not exceed 150 percent of the specified operating torque (see 3.1).
Total resistance	Change shall not exceed $\pm(1$ percent +0.05 ohms).
Visual examination	There shall be no evidence of mechanical damage.

3.23 High temperature exposure. When resistors are tested as specified in 4.7.18, resistors shall meet the following requirements:

Setting stability:	Change shall not exceed 1 percent plus the specified maximum resolution (see 3.1).
Total resistance:	Change shall not exceed $\pm(1$ percent +0.05 ohms).
Operating torque:	Shall not exceed 150 percent of the specified operating torque (see 3.1).
Dielectric withstanding voltage at atmospheric pressure:	As specified in 3.11.
Insulation resistance:	Shall be not less than 1,000 megohms.
Visual examination	There shall be no evidence of mechanical damage.

3.24 Rotational life. When resistors are tested as specified in 4.7.19, the change in total resistance shall not exceed ± 2 percent, and there shall be no mechanical damage.

3.25 Terminal strength. When resistors are tested as specified in 4.7.20, there shall be no evidence of mechanical damage, and resistors shall be electrically continuous.

3.26 Solderability (applicable to terminal types P, W, X, and Y only). When resistors are tested as specified in 4.7.21, the dipped surface of the terminals shall be at least 95 percent covered with a new, smooth, continuous surface free from pin holes. The remaining 5 percent to the terminal surface may show pin holes, voids, or rough spots. These shall not be concentrated in one area. Bare base metal and areas where solder dip has failed to cover the original coating are indications of poor solderability, and shall be cause for failure. In case of dispute, the percentage of coverage with pin holes or rough spots shall be determined by actual measurement of these areas, as compared to the total area.

3.27 Immersion (applicable to terminal types P, W, X, and Y only). When resistors are tested as specified in 4.7.22, no continuous stream of bubbles shall emanate from any concentrated point of the resistor. When resistors are subjected to the dye penetrate test, there shall be no evidence of dye in the internal cavities.

3.28 Fungus. All external materials shall be nonnutrient to fungus or shall be suitably treated to retard fungus growth. The manufacturer shall verify by certification that all external materials are fungus resistant or shall test resistors as specified in 4.7.23. There shall be no evidence of fungus growth on the external surfaces.

3.29 Riveting. When riveting is required, the operation shall be carefully performed to insure that the rivets are tight and satisfactorily headed. Riveting shall not be used in assembling two or more current carrying parts to an insulating material.

3.30 Solder.

3.30.1 Solder, flux, and soldering. Materials and processes for soft soldering shall be as specified in 3.30.1.1 to 3.30.1.3 inclusive.

3.30.1.1 Soft solder. Soft solder, when used for electrical connections, shall conform to composition Type A of J-STD-006.

3.30.1.2 Flux and cleaning agents. Flux for soldering electrical connections shall be resin or resin and alcohol. No acid or acid salts shall be permitted for pretinning of electrical connections, for tinning of electrical connections, or for tinning or soldering of mechanical joints not used to complete electrical circuits. In no case shall acid or acid salts be used where they come into contact with insulation material. Where acid or acid salts are used, as permitted herein, they shall be completely neutralized and removed immediately after use.

3.30.1.3 Process. Soldering connections shall be neat. There shall be no sharp points, rough spots, or surfaces resulting from insufficient heating. The solder shall feather out to a thin edge, indicating proper flowing and wetting action, and shall not be crystallized, overheated, or underheated. The minimum necessary amount of flux shall be used for electrical connections. Wherever practical, excess resin shall be removed with a wire brush and dry cloth. Any resulting loose flakes of resin shall be removed. Insulation resistance material that has been subjected to heating during the soldering operation shall be undamaged and parts fastened thereto shall not have loosened.

3.31 Welding and brazing. Where welding and brazing is employed, the electrical connections shall be mechanically secure and electrically continuous after welding or brazing. Where brazing is employed, only substantially noncorrosive fluxes shall be used, unless it can be shown that corrosive elements have been satisfactorily removed after brazing.

3.32 Marking. Resistors shall be permanently marked with the PIN and manufacturer's name and or trademark. The circuit diagram shall be marked on the resistor as specified in 3.4.3.1. The location of the manufacturer's code symbol shall be at the discretion of the manufacturer. Marking shall remain legible at the end of all tests. There shall be no space between symbols that comprise the PIN. If lack of space requires it, the PIN may be set in two lines. In this event, the PIN shall be divided between the characteristic and terminal symbols, as shown in the following example:

RT10C2
P102

3.33 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.

3.34 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. 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/NCSS 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.

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. Sample units shall be subjected to the qualification inspection specified in table IV, in the order shown. Thirty enclosed sample units shall be subjected to the inspection of group I. The sample shall then be divided equally into five groups of five units each, for group II to VI, inclusive, and subject to the inspection for their particular group. Three of the remaining five enclosed sample units shall be subjected to the inspection of group VII only. The remaining two enclosed sample units shall be subjected to the visual and mechanical examination of group I. Ten additional sample units shall be subjected to group VIII. Qualification shall be extended to other terminal types of the same style by submission of samples to additional testing in accordance with table XII.

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, VII, and VIII. One failure shall be allowed for groups II, III, IV, V and VI, combined. Failures in excess of those allowed shall be cause for refusal to grant qualification.

4.5 Retention of qualification. Every 6 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.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of packaging 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 resistors of the same style produced in a period not to exceed 30 days, produced 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 examination and tests specified in table V and shall be made on the same set of sample units, in the order shown.

TABLE IV. Qualification inspection.

Inspection	Requirements paragraph	Method paragraph	Number of samples	Number of failures allowed <u>1/</u>
<u>Group I</u> <u>2/</u> Visual and mechanical examination <u>3/</u>	3.1, 3.3 to 3.3.2, 3.4 to 3.4.3, 3.4.4 to 3.4.7 incl, 3.29 to 3.32 incl, and 3.34.	4.7.1	30	0
Total resistance	3.7.1	4.7.2.1		
Continuity	3.8	4.7.3		
Actual effective electrical travel	3.9	4.7.4		
Absolute minimum resistance	3.7.2	4.7.2.2		
End resistance	3.7.3	4.7.2.3		
Peak Noise	3.10	4.7.5		
Dielectric withstanding voltage	3.11	4.7.6		
Insulation resistance	3.12	4.7.7		
Torque	3.13	4.7.8		
Thermal shock	3.14	4.7.9		
<u>Group II</u> Resistance temperature characteristic <u>4/</u> Moisture resistance Peak noise	3.15 3.16 3.10	4.7.10 4.7.11 4.7.5	5	1
<u>Group III</u> Shock (specified pulse) Vibration, high frequency Peak noise Salt spray (corrosion)	3.17 3.18 3.10 3.19	4.7.12 4.7.13 4.7.5 4.7.14	5	
<u>Group IV</u> Resistance to soldering heat (applicable to terminal types P, W, X, and Y only) Life Peak noise	3.20 3.21 3.10	4.7.15 4.7.16 4.7.5	5	
<u>Group V</u> Low temperature operation High temperature exposure Peak noise	3.22 3.23 3.10	4.7.17 4.7.18 4.7.5	5	
<u>Group VI</u> Rotational life Peak noise Terminal strength	3.24 3.10 3.25	4.7.19 4.7.5 4.7.20	5	
<u>Group VII</u> Solderability (applicable to terminal types P, W, X, and Y only) Immersion (applicable to terminal types P, W, X, and Y only)	3.26 3.27	4.7.21 4.7.22	5	
<u>Group VIII</u> Fungus	3.28	4.7.23	10	

1/ Failure of a single resistor in one or more tests of a group shall be charged as a single failure.

2/ Nondestructive test.

3/ Marking shall be considered defective only if the marking is illegible. Marking shall remain legible at the end of all tests. Marking is not applicable to unenclosed resistors.

TABLE V. Group A inspection. 1/

Inspection	Requirements paragraph	Method paragraph	Sampling plan
<u>Subgroup 1</u>			
Total resistance	3.7.1	4.7.2.1	4.6.1.2.1.1
Continuity	3.8	4.7.3	
Actual effective electrical travel	3.9	4.7.4	
Absolute minimum resistance	3.7.2	4.7.2.2	
End resistance	3.7.3	4.7.2.3	
Peak noise	3.10	4.7.5	
Immersion (applicable to terminal types P, W, X, and Y only)	3.27	4.7.22	
<u>Subgroup 2</u>			
Visual and mechanical examination 1/	3.1, 3.3 to 3.3.2, 3.4 to 3.4.3, 3.4.4 to 3.4.7 incl, 3.29 to 3.32 incl, and 3.34.	4.7.1	4.6.1.2.1.2
<u>Subgroup 3 2/</u>			
Solderability (applicable to terminal types P, W, X, and Y only)	3.26	4.7.21	4.6.1.2.1.3

1/ Marking defects shall be charged only for illegible, incorrect, or incomplete marking. Any subsequent electrical defect shall not be charged as a marking defect.

2/ The manufacture may request the deletion of the subgroup 3 solderability test, providing an in line process control system for assessing and assuring the solderability of leads can be validated and approved by the qualifying activity. Deletion of the test does not relieve the manufacturer from meeting this test requirement in case of dispute. If the design, material, construction, or processing of the part is changed or if there are any problems, the qualifying activity may require resumption of the test.

4.6.1.2.1 Sampling plan.

4.6.1.2.1.1 Subgroup 1. A sample of parts from each inspection lot shall be randomly selected in accordance with table VI. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with table VI. If one or more defectives are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.1.2 Subgroup 2. A sample of parts from each inspection shall be randomly selected in accordance with table VI. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with table VI. If one or more defectives are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.1.2.1.3 Subgroup 3 (solderability). A sample of five parts from each inspection lot shall be selected subjected to the subgroup 3 solderability test. If there is one or more defects, the lot shall be considered to have failed. As an option, the manufacturer may use electrical rejects from the subgroup 1 tests for all or part of the sample. If there are one or more defects, the lot is rejected. The manufacturer may use one of the following options for corrective action:

- a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.21. Five samples shall be selected from each production lot that formed the failed inspection lot. Production lot samples that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in (b).
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with the Appendix section 5. Following the solder dip, the electrical measurements required in group A, subgroup 1, tests shall be repeated on 100 percent of the lot. The PDA for the electrical measurements shall be as for the subgroup 1 tests. An additional sample shall then be selected in accordance with table VI and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot may be reworked a second time and retested. If the lot fails the second rework the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

TABLE VI. Group A sampling plan.

Lot size	Subgroup 1 Sampling plan	Subgroup 2 Sample plan
1 to 12	100 percent	100 percent
13 to 90	100 percent	13
91 to 150	90	13
151 to 280	125	20
281 to 500	192	29
501 to 1,200	192	34
1,201 to 3,200	192	42
3,201 to 10,000	192	50
10,001 to 35,000	294	60
35,001 to 150,000	294	74
150,001 to 500,000	345	90
500,001 and over	435	102

4.6.1.2.1.4 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied on the contract.

4.6.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table VII, in the order shown, and the sample shall be selected from inspection lots that have passed group A inspection.

TABLE VII. Group B inspection. 1/ 2/

Inspection	Requirement paragraph	Method paragraph	Sampling plan
<u>Subgroup 1</u>			
Actual effective electrical travel	3.9	4.7.4	4.6.1.3.1.1
Dielectric withstanding voltage	3.11	4.7.6	
Insulation resistance	3.12	4.7.7	
Torque	3.13	4.7.8	
<u>Subgroup2</u>			
Thermal shock	3.14	4.7.9	4.6.1.3.1.2

1/ If the manufacturer can demonstrate that this test has been performed 5 consecutive times with zero failures, the frequency of this test, with approval of the qualifying activity, can be performed on an annual basis. If the design, material, construction or processing of the part is changed, or if there are any quality problems or failure, the qualifying activity may require resumption of the original test.

2/ See table XI.

4.6.1.3.1 Sampling plan.

4.6.1.3.1.1 Subgroup 1. A sample of parts shall be randomly selected in accordance with table VIII. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with table VIII. If one or more defects are found in the second sample, the lot shall not be supplied to this specification.

TABLE VIII. Group B sampling plan.

Lot size	Sample size
1 to 25	3
26 to 50	5
51 to 90	6
91 to 150	7
151 to 280	10
281 to 500	11
500 to 1,200	15
1,201 to 3,200	18
3,201 to 10,000	22
10,001 to 35,000	29
35,001 to 150,000	29
150,001 to 500,000	29
500,001 and over	29

4.6.1.3.1.2 Subgroup 2. A sample of parts shall be randomly selected in accordance with table VIII. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with table VIII. If one or more defects are found in the second sample, the lot shall not be supplied to this specification.

4.6.1.3.1.3 Disposition of sample units. Sample units that have passed all of the Group B inspection may be delivered on the contract or order.

4.6.2 Alternate inspection. For the purposes of retention of qualification and conformance inspection (see 4.5 and 4.6), test results on identical items covered by MIL-PRF-39015 may be used.

4.7 Methods of examination and test.

4.7.1 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 3.3.2 inclusive, 3.4 to 3.4.3, 3.4.4 to 3.4.7 inclusive, 3.29 to 3.32, inclusive and 3.34).

4.7.2 DC resistance (see 3.7). Resistors shall be tested in accordance with method 303 of MIL-STD-202. Measuring instruments used for initial and final readings of this test, can be of different styles or models provided performance is equivalent or better.

- a. Measuring apparatus: The same measuring instrument shall be used for all resistance measurements in any one test, but not necessarily for all the tests.
- b. Test voltage: Measurements of resistance shall be made by using the test voltage specified in table IX. The test voltage chosen, whether it be maximum or a lower voltage which would still provide the sensitivity required, shall be applied across the terminals of the resistor. This same voltage shall be used whenever a subsequent measurement is made.

TABLE IX. DC resistance test voltage.

Total resistance nominal (in ohms)	Maximum test voltage (in volts)
10 to 100 incl.	1.0
Over 100 to 1,000 incl	3.0
Over 1,000 to 10,000 incl	10.0
Over 10,000 to 0.1 megohm, incl	30.0

4.7.2.1 Total resistance (see 3.7.1). The total resistance shall be measured as specified in 4.6.2, between the resistance element end terminals (terminals 1 and 3 of figure 1) with contact arm against a stop. The positioning of the contact arm and terminal shall be the same for all subsequent measurements of the total resistance on the same specimen.

4.7.2.2 Absolute minimum resistance (see 3.7.2). The contact arm shall be positioned at one end of the resistance element, so that a minimum value of resistance shall be measured as specified in 4.7.2 between the contact arm and the corresponding end terminal. The same procedure shall be followed for the other end of the resistance element. Rated current through the resistance element shall not be exceeded during this measurement.

4.7.2.3 End resistance (see 3.7.3). The contact arm shall be positioned at the extreme counterclockwise limit of mechanical travel, and the resistance shall be measured as specified in 4.7.2 between the contact arm and the corresponding end terminal. The contact arm shall then be so positioned at the extreme clockwise limit of mechanical travel, and the resistance shall be measured as specified in 4.7.2 between the contact arm and corresponding end terminal. Clockwise and counterclockwise signifies the direction of rotation of the operating shaft when the resistor is viewed from the shaft end.

4.7.3 Continuity (see 3.8). The operating shaft actuator shall be rotated at a uniform rate such that the wiper traverses the effective electrical travel in both direction within 1.0 ± 0.250 minutes. During this rotation, a suitable electrical device shall be connected between the wiper and either end terminal and monitored for smooth and unidirectional change in voltage or resistance. Precaution shall be exercised to prevent excessive current flow in the resistor during the test.

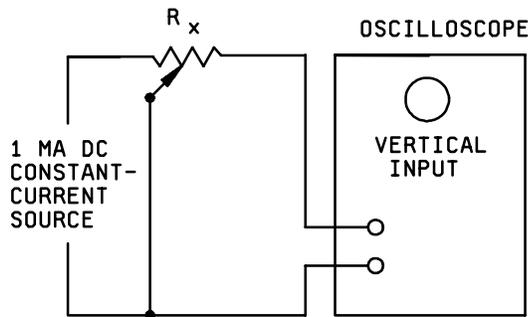
4.7.4 Actual effective electrical travel (see 3.9). The actual effective electrical travel shall be measured by placing the resistor in a suitable device and circuit which will indicate both angular position of the operating shaft and voltage output. The actual effective electrical travel will be the number of turns or degrees of the operating shaft in which a change in contact arm position gives a measurable change in voltage output.

4.7.5 Peak noise (see 3.10). Peak noise resistance shall be measured with the measuring circuit shown in figure 3, or it's equivalent. The operating shaft shall be rotated in both directions through 90 percent of the actual effective travel for a maximum of 6 cycles. If the product passes on any one of the first three cycles, the product is acceptable. Only the last three cycles shall be counted in determining whether or not a noise is observed at least twice in the same location. Acceptance may be determined based on one cycle minimum where compliance to the specification is demonstrated. The rate of rotation of the operating shaft shall be such that the wiper completes 1 cycle in 5 seconds, minimum, to 2 minutes, maximum. The equivalent resistance shall be calculated using the following formula:

$$\text{Noise} = \frac{E_{pn}}{0.001} \text{ ohms}$$

where:

E_{pn} = The peak noise signal voltage presented on the oscilloscope screen.



NOTES:

1. R_x is the test specimen.
2. Oscilloscope bandwidth: DC to 50 kHz.
3. Minimum input impedance: 1.0 megohm at 400 hertz.

FIGURE 3. Peak noise circuit.

4.7.6 Dielectric withstanding voltage (see 3.11).

4.7.6.1 Atmospheric pressure. Resistors shall be tested in accordance with method 301 of MIL-STD-202. The following details and exceptions shall apply:

- a. Special preparation: Resistors shall be clamped, or otherwise mounted on metal plates of sufficient size to extend beyond the resistor extremities, and in such a manner that measurements can be made between terminals tied together and any other external parts.
- b. Magnitude of test voltage: 900 volts root mean square (rms).
- c. Nature of potential: From alternating current (ac) supply at commercial line frequency and waveform.
- d. Points of application of test voltage: Between the resistor terminals tied together and all external metal portions of the resistors and metal mounting plate.
- e. Examination after test: During the tests, the leakage current shall be monitored and the resistors examined for evidence of arcing and breakdown. At the conclusion of the test, resistors shall be examined for evidence of damage.

4.7.6.2 Barometric pressure. Resistors shall be tested in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

- a. Method of mounting: As specified in 4.7.6.1a.
- b. Test condition: C.
- c. Period of time at reduced pressure prior to application of potential: One minute.
- d. Tests during subjection to reduced pressure: A potential of 350 volts from an ac supply at commercial line frequency and waveform shall be applied for one minute.
- e. Points of application: As specified in 4.7.6.1d.
- f. Examination and measurement: As specified in 4.7.6.1e.

4.7.7 Insulation resistance (see 3.12). Resistors shall be tested in accordance with method 301 of MIL-STD-202. The following detail shall apply:

- a. Test condition: C.
- b. Special preparation: As specified in 4.7.6.1a.
- c. Point of application: As specified in 4.7.6.1d.

4.7.8 Torque.

4.7.8.1 Operating (see 3.13.1). The maximum operating torque required to move the contact arm on the resistive element shall be determined at approximately 10, 50, and 90 percent of the actual effective electrical travel by the torque wrench or by any other method acceptable to the government.

4.7.8.2 Clutch (see 3.13.2). The contact arm shall be adjusted to each extreme limit of mechanical travel, and sufficient torque shall be applied to the operating shaft to permit the contact arm to idle for 25 complete mechanical turns of the lead screw actuator. During idle, a suitable electrical indicating device connected between the contact arm terminal and the adjacent end terminal shall be observed for electrical continuity. After idle, the operating shaft shall be rotated in the opposite direction and the indicating device observed to determine if the contact arm reversed direction.

4.7.8.3 Stop (see 3.13.3). resistors shall be mounted by their normal mounting means. The contact arm shall then be rotated to each extreme limit of mechanical rotation, and the specified torque (see 3.1), applied through the operating shaft to the stop.

4.7.9 Thermal shock (see 3.14). Resistors shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

- a. Test condition: B.
- b. Measurement before cycling: Setting stability and total resistance shall be measured as specified in 4.7.9.1 and 4.7.2.1, respectively. Continuity of the contact arm shall be verified by connecting a vacuum tube voltmeter or other suitable indicating device, between the contact arm terminal and the counterclockwise end terminal. The applied voltage shall be in accordance with table IX.
- c. Examination after test: Resistors shall be examined for evidence of mechanical damage.

4.7.9.1 Setting stability. The contact arm shall be set at approximately 40 percent of the actual effective electrical travel. An adequate dc test potential shall be applied between end terminals. The voltage between the end terminals, and the voltage between one end terminal and the contact arm, shall be measured and applied to the following formula:

$$\text{Setting stability} = \frac{E1 \times 100}{E2}$$

where:

- E1 = Voltage across one end terminal and the contact arm terminal.
E2 = Voltage across the end terminals.

The difference between the initial measurement made before the environmental test and the measurement made after the test indicates the setting stability in percent.

4.7.10 Resistance temperature characteristic (see 3.15). Resistors shall be tested in accordance with method 304 of MIL-STD-202. The following details shall apply:

- a. Test temperatures: As specified in table X.
- b. Measurements at the end of each period: Total resistance shall be measured as specified in 4.7.2.1, at the temperature maintained during the period.

TABLE X. Resistance temperature characteristic test temperature.

Sequence	Temperature $\pm 3^{\circ}\text{C}$
1	25 <u>2/</u>
2 <u>1/</u>	-15
3	-55
4	25 <u>2/</u>
5 <u>1/</u>	65
6	150

1/ Not applicable to quality conformance inspection.

2/ This temperature shall be considered the reference temperature for each of the succeeding temperatures.

NOTE: At the option of the manufacturer the reverse sequence may be as follows:

1. Room temperature
2. $+150^{\circ}\text{C} \pm 3^{\circ}\text{C}$
3. Room temperature
4. $-55^{\circ}\text{C} \pm 3^{\circ}\text{C}$

4.7.11 Moisture resistance (see 3.16). Resistors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting: Clamped, or otherwise mounted with the terminals exposed on a stainless steel panel of sufficient size to extend beyond the resistor extremities, and in such a manner as to allow electrical connections to be made to the terminals.
- b. Initial measurement: Immediately following the initial drying period, total resistance shall be measured as specified in 4.7.2.1.
- c. Steps 7a and 7b are not applicable.

- d. Polarization and loading voltage: The resistors shall be divided in two equal groups; one group shall be subjected to polarization and the other group to load.
 - (1) Polarization: During steps 1 to 6 inclusive, a 100 volt dc potential shall be applied with the positive lead connected to the resistor terminals tied together, and the negative lead connected to the mounting plate.
 - (2) Loading voltage: During the first two hours of steps 1 and 4, a dc potential equivalent to 100 percent rated wattage, but not exceeding the maximum rated voltage (see 3.1), shall be applied to the resistors.
- e. Final measurements: Upon completion of steps 6 of the final cycle, the resistors shall be removed from the chamber and air dried for one half hour at room ambient conditions. Samples shall not be subjected to forced air drying. The total resistance and insulation resistance shall then be measured 30 to 60 minutes after removal from the humidity chambers, as specified in 4.7.2.1 and 4.7.7, respectively. The subsequent 24-hour conditioning period and measurements do not apply.
- f. Examination after test: Resistors shall be examined for evidence of mechanical damage.

4.7.12 Shock (specified pulse) (see 3.17). Resistors shall be tested in accordance with method 213 of MIL-STD-202. The following details and exceptions shall apply:

- a. Special mounting means: Resistors shall be mounted by their normal mounting means, with their bodies restrained from movement on an appropriate mounting fixture. The mounting fixture shall be constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the shock test table. Resistors shall be mounted in relation to the test equipment in such a manner that the stress applied is in the direction which would be considered most detrimental.
- b. Test leads: Test leads used during this test shall be no longer than average wire gauge (AWG) size 22 stranded wire, so that the influence of the test lead on the resistor shall be held to a minimum. The test lead length shall be no longer than necessary.
- c. Measurements before shock: Total resistance and setting stability shall be measured as specified in 4.7.2.1 and 4.7.9.1, respectively.
- d. Test condition: I.
- e. Measurement during shock: Each resistor shall be monitored to determine electrical discontinuity of the resistance element, and between the contact arm and element, by a method that shall at least be sensitive enough to monitor or register, automatically, any electrical discontinuity of 0.1 millisecond or greater duration.
- f. Measurement after shock: Setting stability and total resistance shall be measured as specified in 4.7.9.1 and 4.7.2.1, respectively.
- g. Examination after shock: Resistors shall be examined for evidence of mechanical damage.

4.7.13 Vibration, high frequency (see 3.18). Resistors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

- a. Mounting: As specified in 4.7.12a.
- b. Test leads: As specified in 4.7.12b.
- c. Measurement before vibration: As specified in 4.7.12c.
- d. Test condition: D.
- e. Measurement during vibration: As specified in 4.7.12e.
- f. Measurement after vibration: As specified in 4.7.12f, and torque as specified in 4.7.8.1.
- g. Examination after vibration: Resistors shall be examined for evidence of mechanical damage.

4.7.14 Salt spray (corrosion) (see 3.19). Resistors shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- a. Special mounting: As specified in 4.7.11a.
- b. Test condition: A.
- c. Examination after exposure: Resistors shall be examined for corrosion.

4.7.15 Resistance to soldering heat (applicable to terminal types P, W, X, and Y only) (see 3.20). Total resistance shall be measured as specified in 4.7.2.1. All resistor terminals shall be immersed in a pot of molten solder at a temperature of $350^{\circ}\text{C} \pm 10^{\circ}\text{C}$, for a period of 3 seconds ± 0.5 seconds, to a point 0.125 inch from the entry of the terminal into the resistor body. After a minimum of 3 hours have elapsed, total resistance shall be measured as specified in 4.7.2.1. Resistors shall then be examined for evidence of mechanical damage.

4.7.16 Life (see 3.21). Resistors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

- a. Method of mounting: Resistors shall be mounted by their normal mounting means, on a 0.0625 inch thick, glass base, epoxy laminate. The resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no undue draft over the resistors.
- b. Test temperature and tolerance: $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- c. Initial measurements: Measurements may be made inside or outside the chamber. Total resistance and setting stability shall be measured as specified in 4.7.2.1 and 4.7.9.1, respectively.
- d. After resistors have been stabilized at their respective temperatures for at least 8 hours, the resistance between the end terminals, with the contact arm in the position for setting stability, shall be measured.
- e. Operating conditions: Rated dc or ac continuous working voltage at commercial line frequency and waveform (see 3.10), shall be applied intermittently to the end terminals of the resistors, 1.5 hours on and 0.5 hour off, for a total of 1,000 hours, at the test temperature. Each resistor shall dissipate rated wattage, and shall not exceed maximum voltage. Adequate precautions shall be taken to maintain constant voltage on the resistor.
- f. Test condition: D.

- g. Measurement during test: While resistors are still in the oven, resistance shall be measured between the end terminals at the end of the 0.5 hour off period after 50 hours ± 4 hours, 100 hours ± 8 hours, 250 hours ± 12 hours, 500 hours ± 12 hours, 750 hours ± 12 hours, and 1,000 hours ± 12 hours have elapsed and compared to the similar readings taken (see 4.7.16c).
- h. Measurements after test: After resistors have been removed from the oven and returned to room temperature, setting stability and total resistance shall be measured as specified in 4.7.9.1 and 4.7.2.1, respectively, and compared to the similar readings taken in 4.7.16c. Dielectric withstanding voltage (at atmospheric pressure), and torque shall be measured as specified in 4.7.6.1 and 4.7.8.1, respectively.
- i. Examination after test: Resistor shall be examined for evidence of mechanical damage.

4.7.17 Low temperature operation (see 3.22).

4.7.17.1 Mounting. Resistors shall be mounted in such a manner as to allow electrical connections to be made to the terminals.

4.7.17.2 Procedure. Total resistance shall be measured as specified in 4.7.2.1. The resistors shall be placed in a chamber at room temperature. The temperature shall be gradually decreased to $-55^{\circ}\text{C} + 0^{\circ}\text{C}$, -5°C within a period of not less than 1.5 hours. For quality conformance inspection only, and at the option of the manufacturer, the resistors may be placed in the chamber when the chamber is already at the extreme low temperature. After one hour of stabilization at this temperature, setting stability shall be measured as specified in 4.7.9.1. Full rated continuous working voltage (see 3.1 and 3.6) shall be applied for 45 minutes. The resistors may be loaded individually or in parallel. Fifteen $+5$, -0 minutes after removal of voltage, setting stability shall be measured as specified in 4.7.9.1. The temperature in chamber shall be gradually increased to room temperature within a period of not more than 8 hours. The resistors shall be removed from the chamber and maintained at a temperature of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a period of approximately 24 hours. Total resistance shall be measured as specified in 4.7.2.1. Resistors shall then be examined for evidence of mechanical damage.

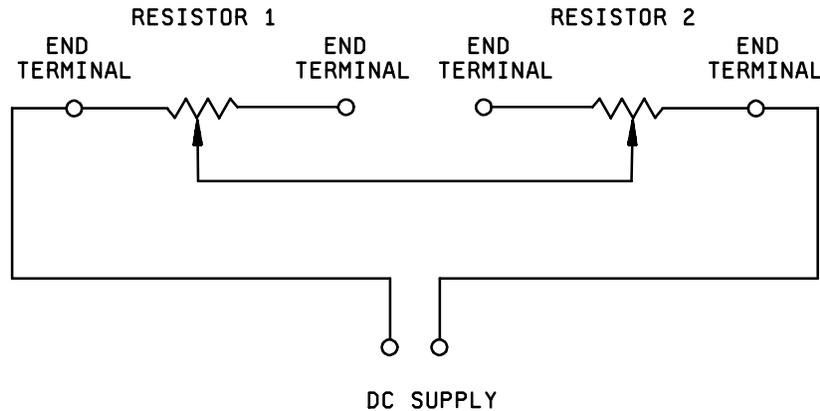
4.7.18 High temperature exposure (see 3.23).

4.7.18.1 Mounting. Resistors shall be mounted in such a manner as to allow electrical connections to be made to the terminals.

4.7.18.2 Procedure. Total resistance and setting stability shall then be measured as specified in 4.7.2.1 and 4.7.9.1, respectively. The resistors shall then be exposed to an ambient temperature of $150^{\circ}\text{C} + 5^{\circ}\text{C}$, -0°C for a period of 250 hours ± 8 hours. Not less than 2 hours after the end of the exposure period, setting stability and total resistance shall be measured as specified in 4.7.9.1 and 4.7.2.1, respectively. Torque shall be measured as specified in 4.7.8.1, except that it shall be determined during the movement of the contact arm from the position for setting stability to the position for total resistance. Dielectric withstanding voltage (at atmospheric pressure), and insulation resistance shall be measured as specified in 4.7.6.1 and 4.7.7, respectively. Resistors shall then be examined for evidence of mechanical damage.

4.7.19 Rotational life (see 3.24).

4.7.19.1 Mounting. Resistors shall be mounted by their normal mounting means on a 0.0625 inch thick, glass base, epoxy laminate. The resistors shall be ganged in pairs, and each pair shall be connected in series, as shown in figure 4, so that a nominally constant current flows through the resistors, irrespective of the contact arm position during the turning of the operating shaft.

FIGURE 4. Rotational life test circuit.

4.7.19.2 Procedure. Total resistance shall be measured as specified in 4.7.2.1. A dc potential, equivalent to that required to dissipate rated wattage across the entire resistive element of resistors having the same total resistance as those under test, but not exceeding the maximum rated voltage, shall then be applied as shown in figure 4. The operating shaft shall be continuously cycled through not less than 90 percent of the actual effective electrical travel, at the rated 1 cycle for 2 minutes ± 0.5 minutes, for a total of 200 cycles. A cycle shall consist of travel through 90 percent of actual effective electrical travel and return to the starting point. After rotation, total resistance shall be measured as specified in 4.7.2.1. Resistors shall then be examined for evidence of mechanical damage.

4.7.20 Terminal strength (see 3.25).

4.7.20.1 Pull (applicable to all terminal types). Resistors shall be tested in accordance with method 211 of MIL-STD-202. The following detail and exception shall apply:

- a. Test condition A: Applied force 2 pounds. Resistors clamped by the resistor body, force applied to each lead individually.
- b. Measurement after test: Resistors shall be examined for evidence of mechanical damage, and tested for electrical continuity.

4.7.20.2 Push (applicable to all terminals except type L). Resistors shall be tested in accordance with method 211 of MIL-STD-202. The following detail and exception shall apply:

- a. Test condition: A, except force shall be applied in the direction towards the resistor body. Applied force 2 pounds. Resistors clamped by the resistor body, force applied to each lead individually.
- b. Measurement after test: Resistors shall be examined for evidence of mechanical damage, and tested for electrical continuity.

4.7.20.3 Bend (applicable to terminal types P, W, X, and Y only). Resistors shall be firmly clamped and each terminal shall be bent through 90 degrees at a point 0.125 inch from the body of the resistor, with the radius of the curvature at the bend approximately 0.03125 inch. The pin shall be returned to the original position, bent 90 degrees in the opposite direction, and again returned to the original position. At the conclusion of the test, the resistors shall be examined for evidence of mechanical damage and tested for electrical continuity.

4.7.21 Solderability (applicable to terminal types P, W, X, and Y only) (see 3.26). Resistors shall be tested in accordance with method 208 of MIL-STD-202. The three pin terminal of each resistor shall be tested.

4.7.22 Immersion (not applicable to L terminations) (see 3.27). The surface shall be clean of any foreign matter immediately before immersion.

- a. Precaution: Precondition resistors in an oven at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 13 minutes ± 2 minutes, or use a fluorocarbon bath maintained at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a period to 1.5 minutes ± 0.5 minutes. Upon completion of precondition, allow resistors to stabilize to room temperature for approximately 13 minutes ± 2 minutes.
- b. Immersion: Immerse resistors (not to exceed 30 samples) into a fluorocarbon bath held at 85°C , $+5^{\circ}\text{C}$, -0°C for a period of 60 seconds ± 5 seconds. The resistor shall be completely submerged in the bath, with no part at a depth of less than 1 inch. Resistors shall be shaken for a maximum of 5 seconds and shall remain in the bath for a period of 1 minute ± 5 seconds. Visually examine resistors for inadequate seals, as evidenced by a continuous stream of bubbles emanating from any concentrated point on the resistor.
- c. Dye penetrate verification: A five piece sample of the product exhibiting inconclusive evidence of compliance to immersion requirements (see 3.27), shall be preconditioned in an oven, stabilized at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 13 minutes ± 2 minutes, or preconditioned in a fluorocarbon bath maintained at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 1 minute ± 5 seconds and immediately upon removal (within 5 seconds), shall be submerged in a dye penetrate solution for 30 seconds minimum. The dye penetrate solution shall consist of 0.1 gram per liter or equivalent, of a soluble stain dye such as crystal violet dissolved in deionized water maintained at room ambient temperature. Upon removal from the dye solution, the sample shall be held at room temperature until external surfaces are dry. The sample shall then be carefully opened and examined under 10X to 30X magnification for evidence of dye penetration into the sealed cavity. Evidence of such penetration verifies loss of immersion seal, and lack of such evidence verifies compliance to the requirement.

4.7.23 Fungus (see 3.28). Resistors shall be tested in accordance with method 508 of MIL-STD-810. Resistors shall be examined for evidence of mechanical damage.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Departments or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory).

6.1 Intended use. The resistors covered by this specification are military unique due to the fact that these devices must be able to operate satisfactorily in military systems under the following demanding conditions: 15 g's of high frequency vibration, 50 g's of shock (specified pulse), 50 g's of acceleration and resistant to salt corrosion. In addition, these military requirements are verified under a qualification system. Commercial components are not designed to withstand these military environmental conditions.

6.2 Acquisition documents. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Title, number, and date of the applicable association specification, and complete PIN (see 1.2.1 and 3.1).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- d. Packaging requirements (see 5.1)
- e. Hardware, whether assembled on resistor (see 3.4.9).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in QPL whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC-VQP, P.O. Box 3990, Columbus, OH 43216-5000.

6.4 Sequence for examinations, measurements, and test. The sequence for examinations, measurements, and tests should be in accordance with table XI.

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

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

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

6.8 Suppression of characteristic. The style in this specification supersedes the equivalent styles of MIL-R-27208C.

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

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

6.11 Retinning leads. If retinning (hot solder dip) of the leads is required, see appendix 5.3.

6.12 Subject term (key word) listing.

- Flexible leads
- Lead screw actuated
- Multiturn
- Potentiometer
- Single turn

TABLE XI. Sequence for examinations, measurements, and tests.

Inspection	Total resistance	Contact resistance variation	Dielectric withstanding voltage (at atmospheric pressure)	Insulation resistance	Torque	Resistance measured between terminals 1 and 3	Setting stability
<u>Group I</u> Visual and mechanical examination Actual effective electrical travel Absolute minimum resistance End resistance Thermal shock	A ^{1/} B, A	 A	 A ^{2/}	 A	 A		 B, A
<u>Group II</u> Resistance temperature characteristic Moisture resistance	 B, A	 A		 A			
<u>Group III</u> Shock (specified pulse) Vibration, high frequency Salt spray (corrosion)	 B, A B, A	 A			 A		 B, A B, A
<u>Group IV</u> Resistance to soldering heat (applicable to terminal types P, W, X, and Y only) Life	 B, A B, A	 A	 A	 A	 A	 B, D, A	 B, A
<u>Group V</u> Low temperature operation High temperature exposure	 B, A B, A	 A	 A	 A	 B, A A		 B, A B, A
<u>Group VI</u> Rotational life Terminal strength Bend test	 B, A	 A					
<u>Group VII</u> Solderability (applicable to terminal types P, W, X, and Y only) Immersion (applicable to terminal types P, W, X, and Y only)							

^{1/} B = Before test, D = During test, A = After test.

^{2/} Atmospheric and barometric.

6.13 PIN. This specification requires a PIN that describes technology and appropriate references to associated documents (see 1.2.1 and 3.1).

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

APPENDIX

PROCEDURE FOR QUALIFICATION INSPECTION

1. SCOPE.

1.1 Scope. This appendix details the procedure for submission of sample, with related data, for qualification inspection of resistors covered by this specification. The procedure for extending qualification required sample to other resistors covered by this specification is also outlined herein. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-1276 - Leads for Electronic Components Parts.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Service, Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094).

3. SUBMISSION

3.1 Sample. A sample consisting of 33 enclosed sample units and 2 unenclosed sample units each with the same terminal type, and of the highest and lowest resistance values in each style and characteristic for which qualification is sought will be submitted.

4. EXTENT OF QUALIFICATION

4.1 Extent of qualification. The resistance range included in the qualification of any one resistor style will be between the highest and lowest resistance value inspected. Qualification of one terminal type may be extended to other terminal types provided the internal construction is the same and additional testing is performed in accordance with table XII.

5. SOLDER DIP (RETIMMING) LEADS

5.1 Solder dip (retinning) leads. The manufacturer may solder dip/retin the leads of products supplied to this specification provided the solder dip process (5.2) or an equivalent process that has been approved by the qualifying activity.

5.2 Qualifying activity approval. Approval of the solder dip process will be based on one of the following options:

- a. When the original lead finish qualified was hot solder dip lead finish 52 of MIL-STD-1276 (Note: The 200 microinch maximum thickness is not applicable). The manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product.

APPENDIX

- b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in 5.2a, approval for the process to be used for solder dip shall be based on the following test procedure:
- (1) Thirty samples of any resistance value for each style and lead finish are subjected to the manufacturers' solder dip process. Following the solder dip process, the resistors are subjected to the dc resistance test (and other group A electricals). No defects are allowed.
 - (2) Ten of the 30 samples are then subjected to the solderability test. No defects are allowed.
 - (3) The remaining 20 samples are subjected to the resistance to solder heat test followed by the moisture resistance test. No defects are allowed.

5.3 Solder dip/retraining options. The manufacturer (or authorized category B or C distributor) may solder dip/retrain as follows:

- a. After the 100 percent group A screening tests. Following the solder dip/retraining process, the electrical measurements required in group A, subgroup 1, test shall be repeated on the lot. Group A, subgroup 1, lot rejection criteria shall be used. Following these tests, the manufacturer shall submit the lot to the group B solderability test as specified in 4.7.21.
- b. As a corrective action, if the lot fails the group A solderability test, the lot may be retrained no more than two times. The lot after retraining shall be 100 percent screened for group A electrical requirements (dc resistance) and parts failing (lot not exceeding PDA for group A, subgroup 1, see (4.6.1.2) these screens shall not be supplied to this specification. If electrical failures are detected after the second retraining operation exceeding 1 percent of the lot shall not be supplied to this specification.
- c. After the group A inspection has been completed: Following the solder dip/retraining process, the electrical measurements required in group A, subgroup 1, 100 percent screening test shall be repeated on 100 percent of the lot. The PDA for the electrical measurements shall be as for the subgroup 1 tests. Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.7.21.

TABLE XII. Additional testing required to extend qualification to other styles.

Terminal types qualified	Terminal type for which qualification is sought	Number of additional sample units		Tests from Table IV to be performed on additional sample units
P, W, or X	L	6	3 highest resistance values 3 lowest resistance values	Test group I moisture resistance and terminal strength <u>1/</u>
P	W or X	6	3 highest resistance values 3 lowest resistance values	Test group I and III and terminal strength <u>1/</u>
P	Y	6	Any resistance value	Visual and mechanical examination
W or X	P	6		
L	P, W, or X	9	6 highest resistance values 3 lowest resistance values	Test groups I, III, VII <u>2/</u> and terminal strength <u>1/</u>
W or X	P	6	Any resistance value	Visual and mechanical examination
X	W	6		
W	X	6		

1/ Where terminal strength is required, the six sample units from the previous test, or six additional sample units may be used at the option of the supplier.

2/ All nine sample units shall be submitted to test group I, then subdivided with six sample units submitted to test group III and the remaining three sample units submitted to test group VII.

MIL-PRF-27208E

Custodians:

Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:

DLA - CC

Review activities:

Army - AR, AT, AV, MI
Navy - AS, MC, OS
Air Force - 19

(Project 5905-1606)