INCH-POUND

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MILITARY 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 a 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 shall be in the following form and as specified (see 3.1 and 6.2):

RT10	C	2	P	102
Style (see 1.2.1.1)	Resistance temperature characteristic (see 1.2.1.2)	Temperature characteristic (see 1.2.1.3)	Terminals (see 1.2.1.4)	Resistance (see 1.2.1.5)

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, wire-wound, 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. Characteristics.

Symbol	Maximum resistance temperature characteristic in percent per °C 1/	Parts per million per °C (ppm) 1/
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: 2750 LOG/ESP Gentile Station, 1060 Hamilton Street, Dayton, OH 45444-5400 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5905

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 per °C	Parts per million per °C (ppm)
	°C	°C
2	85	150

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 1/	Printed circuit pins (edge-mounted)
X 2/	Printed circuit pins (edge-mounted, alternate configuration)
Y 3/	Printed circuit pins (staggered)

1/ Available only in essentially square styles. Pins extend from the edge 180° 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 edge, 90° 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 °C.

2 - Having a temperature characteristic capable of operation at 85°C maximum and derated, at 150°C 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 Government documents.

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

SPECIFICATIONS

FEDERAL

QQ-S-571 - Solder, Tin alloy; Lead-Tin alloy; and Lead alloy.

MILITARY

MIL-R-39015 - Resistors, Wire-wound (Lead Screw Actuated), Established Reliability, General Specification for.
MIL-R-39032 - Resistors, Packaging of.

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
MIL-STD-1276 - Leads for Electronic Components.
MIL-STD-45662 - Calibration Systems Requirements.

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

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for associated detail specifications, specification sheets, or MS standards, the text of this document shall take precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specifications. The individual item requirements shall be as specified herein and in accordance with the applicable associated detail specification. In the event of a conflict between requirements of this specification and the associated detail specification, the latter shall govern (see 6.2).

3.2 Qualification. Resistors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.4 and 6.3).

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

3.3.1 Plastic. Plastic laminates containing a cotton fabric base or plastic molding compounds containing a cotton or wood flour filler shall not be used. When not machined, plastic material 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 resistant steel and the resistance element material is prohibited.

3.4 Design and construction. Resistors shall be of the design, construction, and physical dimensions specified (see 3.1).

3.4.1 Resistance element. The resistance element shall be wound on a suitable form which 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 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 or 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 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 protected by a corrosion-resistant metallic coating, and all terminals or exposed portions of insulated wire shall be suitably treated to facilitate soldering.

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 leads shall be color coded as shown on figure 1.

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.

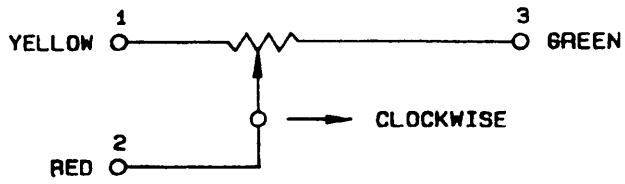


FIGURE 1. Circuit diagram.

3.4.3.2 Solder dip (retinning) leads. The manufacturer may solder dip/retin the leads of product supplied to this specification provided the solder dip process has been approved by the qualifying activity. The manufacturer shall maintain a solder purity in accordance with table IV, during the tinning process.

3.4.3.2.1 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.

b. When the lead originally qualified was not hot solder dip finish 52 of MIL-STD-1276 as prescribed in (a), 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 manufacturer's 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 soldering heat test followed by the moisture resistance test. No defects are allowed.

TABLE IV. Contamination limits.

Contamination	Tinning percent by weight 1/
Copper	0.750
Gold	0.500
Cadmium	0.010
Zinc	0.008
Aluminum	0.008
Antimony	0.500
Iron	0.020
Arsenic	0.030
Bismuth	0.250
Silver	0.750
Nickel	0.250

1/ This is a fixed percentage by weight of the solder.

3.4.3.2.2 Solder dip retinning options. The manufacturer may solder dip/retin as follows:

a. After group A tests. Following the solder dip/retinning process, the electrical measurements required in group A, subgroup 1, tests shall be repeated on the lot. The group A, subgroup 1, lot rejection criteria shall be used. Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.6.21.

b. As a corrective action if the lot fails the group A solderability test.

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 shaft 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 contact arm assembly may 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 on 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.

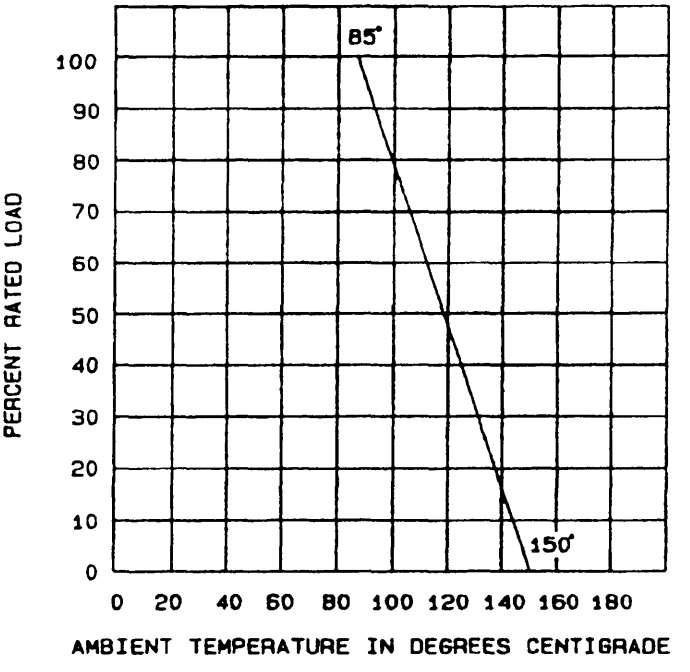


FIGURE 2. Derating curve for high ambient temperatures.

3.1)). When resistor are tested as specified in 4.6.8.2, the contact arm shall idle against the stop without electrical discontinuity or evidence of mechanical damage. The travel of the contact arm shall be capable of reversing direction.

3.13.3 Stops (applicable only to single turn units, unless otherwise specified). When resistors are tested as specified in 4.6.8.3, they shall withstand the stop torque specified (see 3.1), without damage to the contact arm or stop.

3.14. Thermal shock. When resistors are tested as specified in 4.6.9, the change in total resistance shall not exceed ±(1 percent + 0.05 ohm). 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.

3.15 Resistance temperature characteristic. When resistors are tested as specified in 4.6.10, the resistance temperature characteristic, at each of the test temperatures specified in table XII, referred to an ambient temperature of 25°C, shall not exceed ±0.005 percent per °C.

3.16 Moisture resistance. When tested as specified in 4.6.11, resistors shall meet the following requirements:

Total resistance	Change shall not exceed ±(1 percent + 0.05 ohm).
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 4.6.12, the change in total resistance shall not exceed ±(1 percent + 0.05 ohm). 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 4.6.13, 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 ±(1 percent +0.05 ohm).
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.

3.19 Salt spray (corrosion). When resistors are tested as specified in 4.6.14, there shall be no appreciable corrosion.

3.20 Resistance to soldering heat (applicable to terminal types P, W, X, and Y only). When resistors are tested as specified in 4.6.15, the change in total resistance shall not exceed ±(1 percent + 0.05 ohm) and there shall be no evidence of mechanical damage.

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 4.6.17, 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 ±(1 percent + 0.05 ohm).
Visual examination	There shall be no evidence of mechanical damage.

3.23 High temperature exposure. When resistors are tested as specified in 4.6.18, 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 ±(1 percent + 0.05 ohm).
Operating torque	Shall not exceed 150 percent of the specified operating torque.
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 4.6.19, 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 4.6.20, 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 4.6.21, 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 of 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 the 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 pinholes 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 4.6.22, no continuous stream of bubbles shall emanate from any concentrated point of the resistor. When resistors are subjected to the dye penetrant 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 4.6.23. There shall be no evidence of fungus growth on the external surfaces.

3.29 Marking. Resistors shall be marked with the PIN and the manufacturer's name or code symbol. 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 at the discretion of the manufacturer. Marking shall remain legible at the end of all tests. There shall be no space between the symbols which comprise the PIN. If lack of space requires it, the PIN may be placed on two lines or on separate surfaces. In this event, the PIN shall be divided between the characteristic and terminal symbols, as shown in the following example:

RT10C2
P102

3.30 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality, and shall meet the requirements of 3.1, 3.3 to 3.3.2 inclusive, and 3.4 to 3.4.7.2 inclusive, and 3.29 to 3.30.3 as applicable, and shall be free from other defects that will affect life, serviceability, or appearance.

3.30.1 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.

3.30.2 Solder, flux, and soldering. Materials and processes for soft soldering shall be as specified in 3.30.2.1 to 3.30.2.3 inclusive.

3.30.2.1 Soft solder. Soft solder, when used for electrical connections, shall conform to composition Sn60 of QQ-S-571.

3.30.2.2 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.

3.30.2.3 Process. Soldered 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 a 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.

3.30.3 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.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set fourth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspections. Inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.4).

b. Quality conformance inspection (see 4.5).

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

4.4 Qualification inspection. 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 resistors to be subjected to qualification inspection shall be as specified in the appendix to this specification.

4.4.2 Inspection routine. Sample units of any terminal type shall be subjected to the qualification inspection specified in table V, 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 six units each, for groups II to VI, inclusive, and subjected to the inspection for their particular group. The remaining three enclosed sample units shall be subjected to the inspection of group VII only. The two enclosed sample units shall be subjected only to the visual and mechanical examination of group I. Ten 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 XIV.

4.4.3 Failures. Failures in excess of those allowed in table V shall be cause for refusal to grant qualification.

4.4.4 Retention of qualification. In order to retain qualification, the supplier shall forward via the Government inspector at 6-month intervals, to the qualifying activity responsible for qualification, a summary of the results of groups A and B tests, indicating as a minimum the number of lots which have passed and the number of lots that have failed, and a summary of the results of group C tests, including the number and type of any failures. The summary shall include those tests performed during the 6-month period. If the summary of the tests indicates nonconformance with specification requirements, after corrective action as specified in 4.5.2.1.4 has been taken, action will be taken to remove the failing product from the qualified products list. Failure to submit the summary will result in loss of qualification for that product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity at any time during the 6-month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification. In the event no product has been submitted under the specification during the 6-month period, a statement indicating this condition shall be forwarded to the qualifying activity in the manner indicated above. For alternate requirements, see 4.5.3.

TABLE V. Qualification inspection. 1/

Inspection	Requirement paragraph	Method paragraph	Number of failures allowed 2/
Visual and mechanical examination 3/ 4/	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 3.30.3 incl.	4.6.1	
Group I			
Total resistance 4/	3.7.1	4.6.2.1	
Continuity 4/	3.8	4.6.3	
Actual effective electrical travel 4/	3.9	4.6.4	0
Absolute minimum resistance 4/	3.7.2	4.6.2.2	
End resistance 4/	3.7.3	4.6.2.3	
Peak noise 4/	3.10	4.6.5	
Dielectric withstanding voltage 4/	3.11	4.6.6	
Insulation resistance 4/	3.12	4.6.7	
Torque 4/	3.13	4.6.8	
Thermal shock 4/	3.14	4.6.9	
Group II			
Resistance temperature characteristic 4/	3.15	4.6.10	
Moisture resistance	3.16	4.6.11	1
Peak noise	3.10	4.6.5	
Group III			
Shock (specified pulse)	3.17	4.6.12	
Vibration, high frequency	3.18	4.6.13	
Peak noise	3.10	4.6.5	1
Salt spray (corrosion)	3.19	4.6.14	
Group IV			
Resistance to soldering heat (applicable to terminal types P, W, X, and Y only)	3.20	4.6.15	
Life	3.21	4.6.16	1
Peak noise	3.10	4.6.5	
Group V			
Low temperature operation	3.22	4.6.17	
High temperature exposure	3.23	4.6.18	1
Peak noise	3.10	4.6.5	
Group VI			
Rotational life	3.24	4.6.19	
Peak noise	3.10	4.6.5	1
Terminal strength	3.25	4.6.20	
Group VII			
Solderability (applicable to terminal types P, W, X, and Y only)	3.26	4.6.21	
Immersion (applicable to terminal types P, W, X, and Y only)	3.27	4.6.22	0
Group VIII			
Fungus	3.28	4.6.23	0

2 (spans Groups IV, V, VI, and VII)

1/ See table X.
2/ Failure of a single resistor in one or more tests of a group shall be charged as a single failure.
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.
4/ Nondestructive test.

4.5 Quality conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspection. Except as specified in 4.5.2.1.4, delivery of products which have passed the groups A and B inspection shall not be delayed pending the results of group C inspection.

4.5.1.1 Inspection lot. An inspection lot, as far as practicable, shall consist of all resistors of the same style and terminal construction, regardless of the resistance value, produced under essentially the same conditions, and offered for inspection at one time.

4.5.1.2 Group A inspection. Group A inspection shall be as specified in table VI. The tests shall be conducted in the order shown.

4.5.1.2.1 Sampling plan.

4.5.1.2.1.1 Subgroup 1. A sample of parts from each inspection lot shall be randomly selected in accordance with table VII. 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 VII. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE VI. Group A inspection. 1/

Inspection	Requirement paragraph	Method paragraph	Sampling plan
Subgroup 1			See 4.5.1.2.1.1
Total resistance	3.7.1	4.6.2.1	
Continuity	3.8	4.6.3	
Absolute minimum resistance	3.7.2	4.6.2.2	
End resistance	3.7.3	4.6.2.3	
Peak noise	3.10	4.6.5	
Subgroup 2			See 4.5.1.2.1.2
Visual and mechanical examination	3.1, 3.3 to 3.4.3, 3.4.4 to 3.4.7 incl, 3.29 to 3.30.3	4.6.1	
Subgroup 3			See 4.5.1.2.1.3
Solderability (applicable to terminal types P, W, X, and Y only)	3.26	4.6.21	
Subgroup 4			See 4.5.1.2.1.4
Immersion (applicable to terminal types P, S, W, and Y only)	3.27	4.6.22	

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.

4.5.1.2.1.2 Subgroup 2. A sample of parts from each inspection lot shall be randomly selected in accordance with table VII. 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 VII. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.5.1.2.1.3 Subgroup 3 (solderability).

4.5.1.2.1.3.1 Sampling plan. A sample of parts from each inspection lot shall be randomly selected in accordance with table VII and subjected to the subgroup 3 solderability test. If there is one or more defects, the lot shall be considered to have failed.

TABLE VII. Group A inspection sampling plan.

Lot size	Subgroup 1 sampling plan	Subgroup 2 sampling plan	Subgroup 3 sampling plan	Subgroup 4 sampling plan
1 to 8	100 percent	100 percent	5	3
9 to 15	100 percent	13	5	3
16 to 25	100 percent	13	5	3
26 to 50	100 percent	13	5	5
51 to 90	100 percent	13	5	6
91 to 150	125	13	5	7
151 to 280	192	20	5	10
281 to 500	192	29	5	11
501 to 1,200	192	34	5	15
1,201 to 3,200	192	42	5	18
3,201 to 10,000	192	50	8	22
10,001 to 35,000	294	60	13	29
35,001 to 150,000	294	74	20	29
150,001 to 500,000	345	90	20	29
500,001 and over	435	102	20	29

4.5.1.2.1.3.2 Rejected lots. In the event of one or more defects, the inspection lot is rejected. The manufacturer may use one of the following options to rework the lot:

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 3.4.3.2. Following the solder dip, total resistance and immersion tests shall be repeated on 100 percent of the lot. Lot acceptance for electrical measurements shall be as for subgroup 1. A sample of parts shall be randomly selected in accordance with table VII and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot shall be considered rejected and shall not be furnished against the requirements of this specification.

4.5.1.2.1.3.3 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.

4.5.1.2.1.4 Subgroup 4. A sample of parts from each inspection lot shall be randomly selected in accordance with table VII. 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 VII. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.5.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table VIII, in the order shown. The sample shall be selected from inspection lots that have passed group A inspection.

TABLE VIII. Group B inspection. 1/

Inspection	Requirement paragraph	Method paragraph	Sampling procedure
Subgroup 1			
Actual effective electrical travel	3.8	4.6.3	See 4.5.1.3.1.1
Dielectric withstanding voltage	3.10	4.6.5.2	
Insulation resistance	3.11	4.6.6	
Torque	3.12	4.6.7	
Subgroup 2			
Thermal shock	3.13	4.6.8	See 4.5.1.3.1.2

1/ See table XIII.

4.5.1.3.1 Sampling plan.

4.5.1.3.1.1 Subgroup 1. A sample of parts shall be randomly selected in accordance with table IX. 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 IX. If one or more defects are found in the second sample, the lot shall not be supplied to this specification.

TABLE IX. Group B sampling plan.

Lot size	Group B sampling plan
1 to 8	3
9 to 15	3
16 to 25	3
26 to 50	5
51 to 90	6
91 to 150	7
151 to 280	10
281 to 500	11
501 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

4.5.1.3.1.2 Subgroup 2 . A sample of parts shall be randomly selected in accordance with table IX. 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 IX. If one or more defects are found in the second sample, the lot shall not be supplied to this specification.

purchase order.

4.5.2 Periodic inspection.

4.5.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in table X, in the order shown. They shall be performed on sample units that have passed the group A inspection and subgroup 1 of group B inspection.

4.5.2.1.1 Sampling plan.

4.5.2.1.1.1 Quarterly. Every quarter, 12 sample units of the highest resistance value in each style (currently produced) shall be inspected. Six sample units shall be subjected to the tests of subgroup 1 and the remaining six subjected to the tests of subgroup 2.

4.5.2.1.1.2 Semiannually. Every 6 months, six sample units of the critical resistance value, or nearest lower value to the critical value, in each style produced during the quarter prior to semiannual testing shall be inspected.

4.5.2.1.1.3 Annually. Every 12 months, six sample units of any resistance value in each style shall be subjected to the inspection of subgroup 1. In addition, six sample units of the lowest resistance value in each style, produced during the quarter prior to semiannual inspection, shall be subjected to the inspection of subgroup 2.

4.5.2.1.2 Failures. If the number of failures exceed the number allowed in table X, the sample shall be considered to have failed.

4.5.2.1.3 Disposition of sample units. Sample units subjected to group C inspection shall not be delivered on the contract or purchase order.

TABLE X. Group C inspection. 1/

Inspection	Requirement paragraph	Method paragraph	Number of 2/ failures allowed
Quarterly			
Subgroup 1 (6 sample units)			
Resistance temperature characteristic	3.15	4.6.10	1 / 1
Moisture resistance	3.16	4.6.11	
Peak noise	3.10	4.6.5	
Subgroup 2 (6 sample units)			
Rotational life	3.24	4.6.19	1 / 1
Peak noise	3.10	4.6.5	
Terminal strength	3.25	4.6.20	
Semiannually (6 sample units)			
Resistance to soldering heat (applicable to types P, S, W, X, and Y)	3.20	4.6.15	1
Life	3.21	4.6.16	
Peak noise	3.10	4.6.5	
Annually			
Subgroup 1 (6 sample units)			
Shock (specified pulse)	3.17	4.6.12	1 / 1
Vibration, high frequency	3.18	4.6.13	
Peak noise	3.10	4.6.5	
Salt spray (corrosion)	3.19	4.6.14	
Subgroup 2 (6 sample units)			
Low temperature operation	3.22	4.6.17	1
High temperature exposure	3.23	4.6.18	
Peak noise	3.10	4.6.5	

1/ See table XIII.
2/ Failure of a resistor in one or more tests of a subgroup, or the quarterly inspection period, shall be charged as a single failure.

4.5.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall notify the qualifying activity and cognizant inspection activity of such a failure and take corrective action on the materials or processes, or both, as warranted, and on all units of production which can be corrected and which were manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action has been taken. Group B inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the qualifying activity). Group A inspection may be reinstituted; however, final acceptance and shipment shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.5.3 Alternate inspection. For the purposes of retention of qualification and quality conformance inspection (see 4.4.4 and 4.5), test data on identical items covered by MIL-R-39015 may be used.

4.5.4 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-R-39032.

4.6 Methods of inspection.

4.6.1 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, and 3.29 to 3.30.3 inclusive).

4.6.2 DC resistance (see 3.7). Resistors shall be tested in accordance with method 303 of MIL-STD-202. The following details shall apply:

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 XI. The test voltage chosen, whether it be the 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 resistance measurement is made.

TABLE XI. DC resistance test voltage.

Total resistance nominal	Maximum test voltage
ohms	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

4.6.2.1 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 the 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.

4.6.2.2 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 4.6.2 between the contact arm and 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.

4.6.2.3 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 4.6.2 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 4.6.2 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.

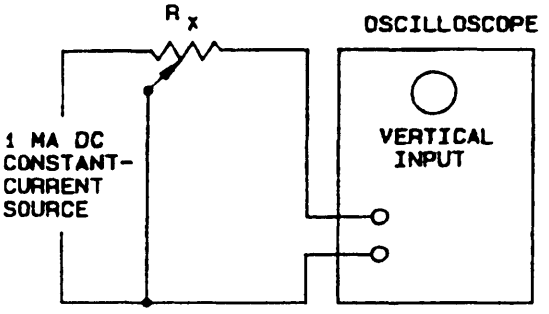
4.6.3 Continuity (see 3.8). The operating shaft actuator shall be rotated at a uniform rate such that the wiper traverses the effective electrical travel in both directions within 1.0 ±0.250 minutes. During this rotation, a suitable electrical device shall be connected between the wiper and either end 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.

4.6.4 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.

4.6.5 Peak noise (see 3.10). Peak noise resistance shall be measured with the measuring circuit shown on figure 3, or its equivalent. The operating shaft shall be rotated in both directions through 90 percent of the actual effective electrical travel for a total of 6 cycles. Only the last three cycles shall be counted in determining whether or not a noise is observed at least twice in the same location. 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:

$$\text{Noise} = \frac{Epn}{0.001} \quad \text{ohms}$$

where:
Epn = The peak noise signal voltage presented on the oscilloscope screen.



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

FIGURE 3. Peak noise circuit.

4.6.6 Dielectric withstanding voltage (see 3.11).

4.6.6.1 Atmospheric pressure. Resistors shall be tested in accordance with method 301 of MIL-STD-202. The following details 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 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 terminals tied together and all external metal portions of the resistors and metal mounting plate.

e. Examination and measurements: 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.

4.6.6.2 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 4.6.6.1a.

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 1 minute.

e. Points of application: As specified in 4.6.6.1.d.

f. Examinations and measurements: As specified in 4.6.6.1e.

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

a. Test condition: A or B, whichever is more practical.

b. Special preparation: As specified in 4.6.6.1a.

c. Points of application: As specified in 4.6.6.1d.

4.6.8 Torque.

4.6.8.1 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.

4.6.8.2 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.

4.6.8.3 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.

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

a. Test condition: B.

b. Measurement before cycling: Setting stability and total resistance shall be measured as specified in 4.6.9.1 and 4.6.2.1, 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 XI.

c. Examination after test: Resistors shall be examined for evidence of mechanical damage.

4.6.9.1 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.

4.6.10 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 XII.

b. Measurements at the end of each period: Total resistance shall be measured as specified in 4.6.2.1, at the temperature maintained during the period.

TABLE XII. Resistance temperature characteristic test temperature.

Sequence	Temperature
	°C
1	25 2/
2 1/	-15
3	-55
4	25 2/
5 1/	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°C ±3°C
3. Room temperature
4. -55°C ±3°C

4.6.11 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 4.6.2.1.

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 step 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 4.6.2.1 and 4.6.7, 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.

4.6.12 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 larger than 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 4.6.2.1 and 4.6.9.1, respectively.

d. Test condition: I.

e. Measurements during shock: Each resistor shall be monitored to determined 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. Measurements after shock: Setting stability and total resistance shall be measured as specified in 4.6.9.1 and 4.6.2.1, respectively.

g. Examination after shock: Resistors shall be examined for evidence of mechanical damage.

4.6.13 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 4.6.12a.

b. Test leads: As specified in 4.6.12b.

c. Measurements before vibration: As specified in 4.6.12c.

d. Test condition: D.

e. Measurement during vibration: As specified in 4.6.12e.

f. Measurements after vibration: As specified in 4.6.12f, and torque as specified in 4.6.8.1.

g. Examination after vibration: Resistors shall be examined for evidence of mechanical damage.

4.6.14 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 4.6.11a.

b. Test condition: A.

c. Examination after exposure: Resistors shall be examined for corrosion.

4.6.15 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 4.6.2.1. All resistor terminals shall be immersed in a pot of molten solder at a temperature of 350°C ±10°C, for a period of 3 ±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 4.6.2.1. Resistors shall then be examined for evidence of mechanical damage.

4.6.16 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 temperatures and tolerances: 85°C ±5°C.

c. Initial measurements: Measurements may be made inside or outside the chamber. Total resistance and setting stability shall be measured as specified in 4.6.2.1 and 4.6.9.1, 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 3.1), 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, but 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 ±4, 100 ±8, 250 ±12, 500 ±12, 750 ±12, and 1,000 ±12 hours have elapsed and compared to the similar readings taken (see 4.6.16c).

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 4.6.9.1 and 4.6.2.1, respectively, and compared to the similar readings taken in 4.6.16c. Dielectric withstanding voltage (at atmospheric pressure), and torque shall be measured as specified in 4.6.6.1 and 4.6.8.1, respectively.

i. Examination after test: Resistors shall be examined for evidence of mechanical damage.

4.6.17 Low temperature operation (see 3.22).

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

4.6.17.2 Procedure. The total resistance shall be measured as specified in 4.6.2.1. The resistors shall then be placed in a chamber at room temperature. The temperature shall be gradually decreased to -55°C, +0°C, -5°C within a period of not less than 1.5 hours. For quality conformance inspection only, and at the option of the supplier, resistors may be placed in the chamber when the chamber is already at the extreme low temperature. After 1 hour of stabilization at this temperature, setting stability shall be measured as specified in 4.6.9.1. The temperature in the 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°C ±5°C for a period of approximately 24 hours. Total resistance shall again be measured as specified in 4.6.2.1. Resistors shall then be examined for evidence of mechanical damage.

4.6.18 High temperature exposure (see 3.23).

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

4.6.18.2 Procedure. Total resistance and setting stability shall then be measured as specified in 4.6.2.1 and 4.6.9.1, respectively. The resistors shall then be exposed to an ambient temperature of 150°C +5°C, -0°C for a period of 250 ±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 4.6.9.1 and 4.6.2.1, respectively. Torque shall be measured as specified in 4.6.8.1, 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 measured as specified in 4.6.6.1 and 4.6.7, respectively. Resistors shall then be examined for evidence of mechanical damage.

4.6.19 Rotational life (see 3.24).

glass base, epoxy laminate. The resistors shall be ganged in pairs, and each pair shall be connected in series, as shown on 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.

4.6.19.2 Procedure. Total resistance shall be measured as specified in 4.6.2.1. 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 on 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 ±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 4.6.2.1. Resistors shall then be examined for evidence of mechanical damage.

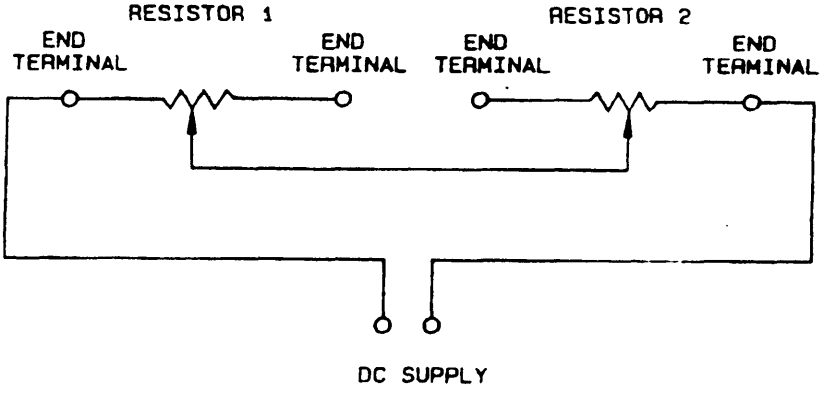


FIGURE 4. Rotational life test circuit.

4.6.20 Terminal strength (see 3.25).

4.6.20.1 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.

4.6.20.2 Push (applicable to all terminal 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 toward the resistor body. Applied force - 2 pounds. Resistor clamped by the resistor body, force applied to each terminal individually.

b. Measurement after test: Resistors shall be examined for evidence of mechanical damage, and tested for electrical continuity.

4.6.20.3 Bend (applicable to terminal types P, W, X, and Y only). Resistors shall be firmly clamped and each terminal shall be bent through 90° at a point .125 inch from the body of the resistor, with the radius of the curvature at the bend approximately .03125 inch. The pin shall be returned to the original position, bent 90° in the opposite direction, and again return 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.

4.6.21 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.

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

a. Precondition: Precondition resistors in an oven at 125°C ±5°C for 13 ±2 minutes, or use a fluorocarbon bath maintained at 125°C ±5°C for a period of 1.5 ±0.5 minutes. Upon completion of precondition, allow resistors to stabilize to room temperature for approximately 13 ±2 minutes.

b. Immersion: Immerse resistors (not to exceed 30 samples) into a fluorocarbon bath held at 85°C, +5°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 penetrant 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°C ±5°C for 13 ±2 minutes, or preconditioned in a fluorocarbon bath maintained at 125°C ±5°C for 1 minute ±5 seconds and immediately upon removal (within 5 seconds), shall be submerged in a dye penetrant solution for 30 seconds minimum. The dye penetrant 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. Upon removal from the dye solution, the sample shall be held at room temperature until external surfaces are dry. The samples 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 requirements.

4.6.23 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 requirements. The requirements for packaging shall be in accordance with MIL-R-39032.

6. NOTES

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

6.1 Intended use. Resistors covered by this specification are intended for use in electronic equipment, and are used for matching, balancing, and adjusting circuit variables in computers, telemetering equipment, and other applications.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of the DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Title, number, and date of the applicable associated detail specification, and complete PIN (see 1.2.1 and 3.1).

d. Levels of preservation and packaging and packing, and applicable marking (see section 5).

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 Qualified Products List QPL No. 27208 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 purchase orders for the products covered by this specification. The activity responsible for the qualified products list is the US Air Force; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, OH 45444.

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

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 circuits 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. Supersession of characteristic. The styles in this specification supersede 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 3.4.3.2.

6.12 PIN. PIN is a new term encompassing terms previously used in specifications such as part number, type designation, identification number, etc., (see 1.2.1).

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

TABLE XIII. 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
Group I							
Visual and mechanical examination	A						
Actual effective electrical travel							
Absolute minimum resistance							
End resistance		A	A—atmospheric and barometric	A	A		
Thermal shock	B, A						B, A
Group II							
Resistance temperature characteristic							
Moisture resistance	B, A	A		A			
Group III							
Shock (specified pulse)	B, A						B, A
Vibration, high frequency	B, A	A			A		B, A
Salt spray (corrosion)							
Group IV							
Resistance to soldering heat (applicable to terminal types P, S, W, X, and Y only)	B, A						
Life	B, A	A	A	A	A	B, D, A	B, A
Group V							
Low temperature operation	B, A				B, A		B, A
High temperature exposure	B, A	A	A	A	A		B, A
Group VI							
Rotational life	B, A	A					
Terminal strength							
Bend test							
Group VII							
Solderability (applicable to terminal types P, W, X, and Y only)							
Immersion (applicable to terminal types P, W, X, and Y only)							

NOTE: B = Before test, D = During test, A = After test.

APPENDIX
PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 Scope. This appendix details the procedure for submission of samples, with related data, for qualification inspection of resistors covered by this specification. The procedure for extending qualification of 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.

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

30. SUBMISSION

30.1 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 shall be submitted.

30.2 Test data. When examinations and tests are to be performed at a Government laboratory, prior to submission, all sample units shall be subjected to all of the examinations and tests indicated as nondestructive in table V. Each submission shall be accompanied by the test data obtained from these examinations and tests. The performance of the destructive tests by the supplier on a duplicate set sample units is encouraged, although is not required. All test data shall be submitted in duplicate.

30.3 Description of items. The supplier shall submit a detailed description of the resistors being submitted for inspection, including material used for protective housing or enclosure.

40. EXTENT OF QUALIFICATION

40.1 Extension 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 XIV.

TABLE XIV. 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 V to be performed on additional sample units
P, W, or X	L	6 — 3 highest resistance value; 3 lowest resistance value	Test group I moisture resistance and terminal strength 1/
P	W or X	6 — 3 highest resistance value; 3 lowest resistance value	Test groups I and III and terminal strength 1/
P	Y	6 any resistance value	Visual and mechanical examination
W or X	P	6 any resistance value	Visual and mechanical examination
L	P, W, or X	9 — 6 highest resistance value; 3 lowest resistance value	Test groups I, III, VII 2/ and terminal strength 1/
W or X	P	6 any resistance value	Visual and mechanical examination
X	W	6 any resistance value	Visual and mechanical examination
W	X	6 any resistance value	Visual and mechanical examination

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.

CONCLUDING MATERIAL

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

Review Activities:
Army - AR, MI
Navy - AS, OS
Air Force - 17, 80

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

Preparing activity:
Air Force - 85

Agent:
DLA - ES

(Project 5905-1254)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-R-27208D	

3. DOCUMENT TITLE

Resistor, Variable, Wire-wound, Nonprecision

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON
DDRESS (Include Zip Code)	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340