INCH-POUND

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MILITARY SPECIFICATION

# RESISTOR, VARIABLE, WIRE-WOUND (LOW OPERATING TEMPERATURE), GENERAL SPECIFICATION FOR

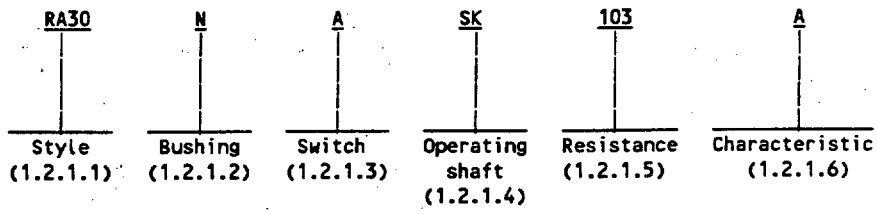
This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the general requirements for variable resistors having a resistance element of wire, wound on an insulating strip shaped in an arc, so that a contact bears uniformly on the resistance element when adjusted by a control shaft. These resistors are capable of full load operation at an ambient temperature of +40°C and are suitable for continuous operation when properly derated, at a maximum temperature of +105°C.

1.2 Classification.

1.2.1 Part or Identifying Number (PIN). The PIN is identified in the following form and as specified (see 3.1 and 6.1):




1.2.1.1 Style. The style is identified by the two letter symbol "RA" followed by a two-digit number; the letters identify low operating-temperature, wire-wound, variable resistors and the number identifies the size and power rating.

1.2.1.2 Bushing. The type of bushing is identified by a single letter in accordance with table I.

TABLE I. Bushing.

| Symbol | Bushing |
|---|---|
| N | Standard |
| L | Locking |
| S | Shaft and panel-sealed (standard) |
| T | Shaft and panel-sealed (locking) |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Research Laboratory ATTN: AMSRL-EP-RD Fort Monmouth, NJ 07703-5302 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of the document or by letter

AMSC N/A

FSC 5905

1.2.1.3 Switch. The type of attached switch or absence of a switch is identified by a single letter in accordance with table II.

TABLE II. Switch.

| Symbol | Switch |
|---|---|
| A | No switch |
| B 1/ | Single pole, single throw switch which is actuated to the "on" position at the start of clockwise rotation. |

1/ For replacement purposes only. Not to be used for new design.

1.2.1.4 Operating shaft. The operating shaft styles are identified by a two letter symbol. The first letter indicates operating shaft in accordance with table III, and the second letter indicates operating shaft length, as specified (see 3.1).

TABLE III. Style of operating shaft.

| Symbol | Shaft |
|---|---|
| S | Slotted |

1.2.1.5 Resistance. The nominal total resistance value expressed in ohms is identified by a three digit number; the first two digits represent significant figures and the last specified the number of zeros to follow. When fractional values of an ohm are required, the letter "R" shall be substituted for one of the significant digits to represent the decimal point, and succeeding digits of the group shall represent significant figures; e.g., 3R0 signifies 3.0 ohms.

1.2.1.6 Resistance characteristic. The resistance characteristic is identified by a single letter in accordance with table IV.

TABLE IV. Resistance characteristic.

| Symbol | Resistance taper | Resistance tolerance |
|---|---|---|
| | | Percent (±) |
| A | A | 10 |
| C | C | 10 |
| E | F | 10 |

1.2.1.7 Example of PIN. The PIN RA20NASK502A signifies:

RA20 - A 2 watt, low operating temperature, wire-wound, variable resistor of the dimensions specified (see 3.1).
N - Standard 0.375 bushing.
A - No switch.
SK - Slotted shaft 2.5 inches long.
502 - Nominal total resistance value of 5,000 ohms.
A - Linear taper with resistance tolerance of ±10 percent.

## 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. |
| QQ-B-654 | - | Brazing Alloys, Silver. |

MILITARY

| | | |
|---|---|---|
| MIL-R-19/1 | - | Resistors, Variable, Wirewound (Low Operating Temperature), Style RA10. |
| MIL-R-19/2 | - | Resistors, Variable, Wirewound (Low Operating Temperature), Style RA20. |
| MIL-R-19/3 | - | Resistors, Variable, Wirewound (Low Operating Temperature), Style RA30. |
| MIL-R-39032 | - | Resistors, Packaging of. |

STANDARDS

FEDERAL

| | | |
|---|---|---|
| FED-STD-H28 | - | Screw Thread Standards for Federal Services. |

MILITARY

| | | |
|---|---|---|
| MIL-STD-202 | - | Test Methods for Electronic and Electrical Component Parts. |
| 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, 700 Robins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (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 part requirements shall be as specified herein and in accordance with the applicable associated detail specifications. In the event of a conflict between requirements of this specification and the detail specifications, 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.

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

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

3.4.1 Windings. The resistance element shall consist of a winding of resistance wire or ribbon, on a suitable form, which shall not char or break down at any combination of temperatures and loads specified herein. The element shall be wound in a manner to conform with the specified taper. Joints, welds, and bonds shall be held to an absolute minimum.

3.4.2 Resistance wire. The resistance wire used shall possess a substantially uniform cross section of conductor. The wire shall be as free as practicable from particles of impurity and grain growth or other factors contributing to stop weakness. In no case shall the wire diameter or ribbon thickness be less than .00175 inch (0.0445 mm) nominal before winding or less than .00156 inch (0.0396 mm) absolute minimum after winding.

3.4.3 Operating shafts. Operating shafts shall be made of corrosion resistant metal or metal which has been plated for corrosion resistance, and shall be electrically insulated from current carrying parts. The slotted portion, diameter, and length of the operating shafts shall be as specified (see 3.1). In all cases, operating shafts shall be of such length that the slot depth will not interfere with shaft retainers.

3.4.4 Rotation. The total mechanical rotation and electrical rotation shall be defined on figure 1, and as specified (see 3.1). The theoretical electrical rotation of resistors with switches shall be equal to the rotation from the stop at the end opposite the switch to the point where the members just engage to actuate the switch to the "off" position.

3.4.4.1 Clockwise taper. A clockwise taper is a resistance taper in which the resistance varies approximately as shown on figure 2, increasing as the rotation angle increases in a clockwise direction as viewed from the operating shaft, and measured between the left terminal and the rotating contact terminal, indicated as 1 and 2, respectively, on figure 1.

3.4.4.2 Counterclockwise taper. A counterclockwise taper is a resistance taper in which the resistance varies approximately as shown on figure 3 increasing as the rotation angle increases in a counterclockwise direction as viewed from the operating shaft, and measured between the right terminal and the rotating contact terminal indicated as 3 and 2, respectively, on figure 1.

3.4.5 Contact-arm assembly. Contact pressure on the resistance element shall be maintained uniformly by positive pressure and shall be such as to permit smooth electrical and mechanical control of the resistor over the entire range of electrical rotation (see 3.1) within the resistance rating. The rotating contact shall have continuous electrical contact with its terminal through the entire mechanical rotation and shall be electrically insulated from the operating shaft, bushing, and resistor housing.

3.4.5.1 Stops. A stop shall be employed to limit the mechanical rotation of the contact-arm assembly.

3.4.6 Terminals. Resistors and attached switches shall be supplied with external terminal lugs or terminal lugs of such size and styles as to permit accommodating and soldering of three .032 inch (0.81 mm) diameter (AWG size 20, stranded) wires for resistors with .250 inch (6.35 mm) diameter operating shaft, and three .025 inch (0.64 mm) diameter (AWG 22 solid) wires for resistors with .125 inch (3.18 mm) diameter operating shafts. Terminals shall be suitably treated to facilitate soldering.

3.4.6.1 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 V, during the tinning process.

TABLE V. 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.

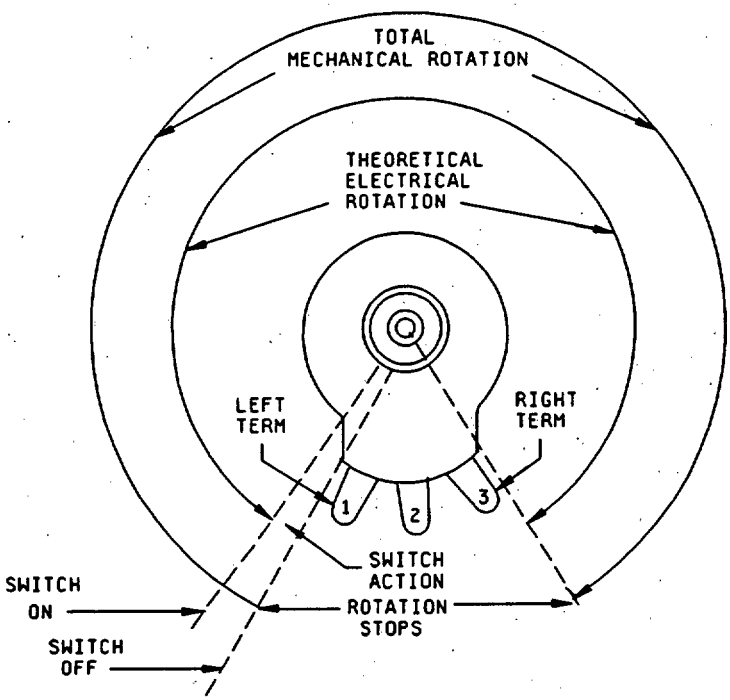



FIGURE 1. Definition of rotation (shaft end view).

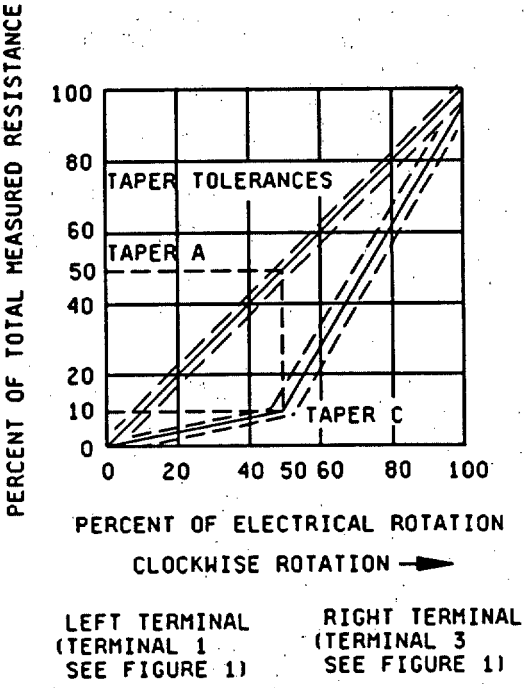



FIGURE 2. Clockwise taper.

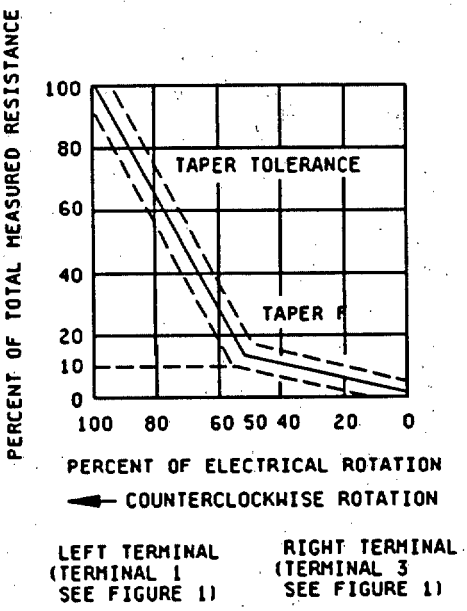



FIGURE 3. Counterclockwise taper.

3.4.6.1.1 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 (3.4.6.1.1a), 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.

3.4.6.1.2 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 4.6.17.

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

3.4.7 Solder. Solder for electrical connections shall be in accordance with QQ-B-654 or QQ-S-571.

3.4.8 Hardware. Each resistor shall be furnished with a corrosion-resistant, internal tooth lockwasher, a hexagonal mounting nut, and a locking nut of the size specified (see 3.1). Hardware shall not be assembled on the resistor unless otherwise specified (see 6.1). For direct Government orders, hardware shall be assembled on the resistor.

3.4.8.1 Standard bushings. When standard bushings are specified, the bushings shall be as shown for the applicable style of resistor (see 3.1).

3.4.8.2 Locking bushings. When locking bushings are specified, the bushings shall be as shown for the applicable style of resistor (see 3.1).

3.4.8.3 Nonturn device. A nonturn device shall be furnished on resistors, which will prevent their rotation with respect to the surface on which they are mounted. The location of the nonturn device and its widest dimension shall be as specified (see 3.1). If the nonturn device is not symmetrical about its vertical axis, it shall be so placed that a plane passed perpendicular to the widest dimension and through its center shall pass through the axis of the operating shaft, and shall be an integral part of the resistor or permanently attached thereto.

3.4.9 Threaded parts. All threaded parts shall be in accordance with Handbook H-28 and as specified (see 3.1).

3.4.9.1 Securing of screws, nuts, and threaded parts. All screw-thread assemblies shall be made resistant to loosening under vibration.

3.4.10 Protective housing or enclosure (when applicable see 3.1). 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 form an 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.

3.4.11 Shaft and panel seals. When shaft and panel seals are specified (see 3.1), the panel seal may be an integral part of the resistor or may be detachable.

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

$$E = \sqrt{PR}$$

Where:

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

3.6 Power rating. The resistors shall have a power rating based on continuous full-load operation at the ambient temperature of +40°C. The power rating is dependent on the ability of the resistors to meet the requirements specified in life test. For temperatures in excess of that specified, the load shall be derated as shown on figure 4. Power rating as specified (see 3.1) is 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 engaged resistance.

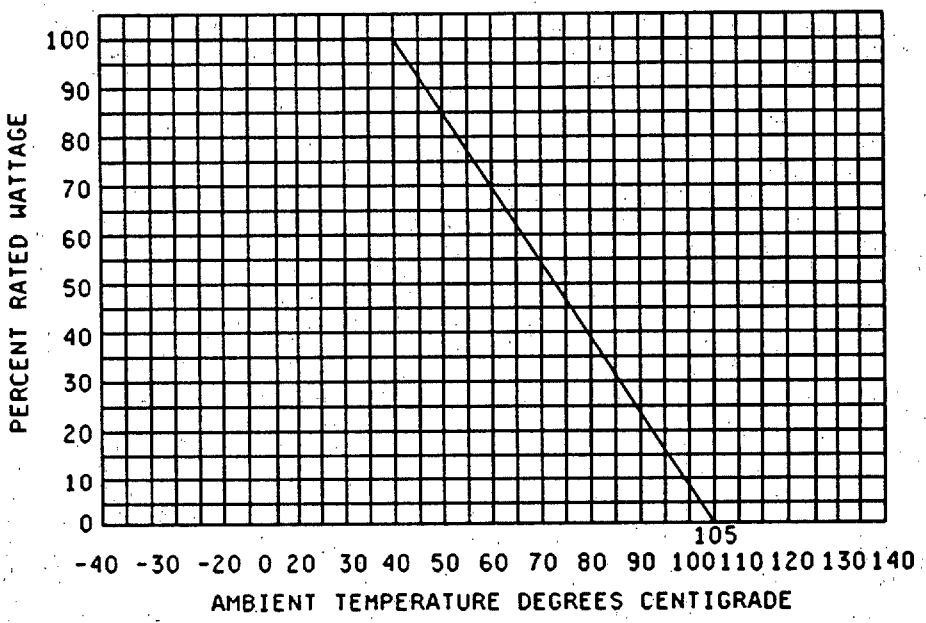



FIGURE 4. Power rating curve for continuous duty.

3.7 Dielectric withstanding voltage. When resistors or switches, as required, are tested as specified in 4.6.2, there shall be no evidence of damage, arcing, or breakdown. The leakage current shall not exceed 1 milliampere.

3.8 DC resistance (see 4.6.3).

3.8.1 Total resistance. When resistors are tested as specified in 4.6.3.1, the total direct-current (dc) resistance shall equal the nominal resistance value plus or minus the resistance tolerance.

3.8.2 Resistance taper. A linear resistance taper is one having a constant change of resistance with angular rotation. A nonlinear resistance taper is one having variation or lack of constancy in the change of resistance with angular rotation. When resistors are tested as specified in 4.6.3.2, the resistance taper shall conform in general shape to the nominal curve shown on figures 2 or 3, as applicable. The angle at which any percent of measured resistance is effective shall be within ±5 percent of the total effective electrical rotation of the specified position as shown on figures 2 and 3, for tapers A and C and taper F, respectively (see 3.1).

3.8.3 Minimum resistance. When resistors are tested as specified in 4.6.3.3, the resistance measured between the rotating contact arm terminal and the adjacent resistance-element terminal shall not exceed the applicable value listed in table VI.

TABLE VI. Minimum resistance.

| Total resistance, nominal | Maximum resistance at minimum setting | |
|---|---|---|
| | All styles with .250 inch diameter shaft | All styles with .125 inch diameter shaft |
| Ohms | Ohms | Percent |
| Up to and including 15 | | 5.0 |
| Over 15 | | 3.0 |
| 3 to 50 incl. | 0.3 | |
| 51 to 100 incl. | 0.5 | |
| over 100 | 0.2 percent of the nominal resistance value or 1.0 ohm whichever is greater | |

3.9 Torque (see 4.6.4).

3.9.1 Operating. When resistors are tested as specified in 4.6.4.2, the torque required to rotate the contact arm shall be as specified (see 3.1). An additional torque of 15 ounce-inches shall be permitted for operation of attached switches.

3.9.2 Stop. When resistors are tested as specified in 4.6.4.3, resistors shall withstand the stop torque specified (see 3.1) without damage to the contact arm, stop and nonturn device.

3.9.3 Locking. When resistors are tested as specified in 4.6.4.4, resistors with locking bushings shall withstand the locking torque specified (see 3.1), without damage to the bushings, threads and nonturn device. The resistance value shall not change in excess of 3 percent of the total resistance value.

3.10 Low temperature storage. When resistors are tested as specified in 4.6.5, the maximum change in resistance shall not exceed ±4 percent.

3.11 Low temperature operation. When resistors are tested as specified in 4.6.6, the torque required to effect rotation of the contact arm shall not be greater than 40 ounce-inches. This includes switch action, if attached. The maximum change in resistance shall not exceed ±4 percent.

3.12 Thermal shock. When resistors are tested as specified in 4.6.7, resistor shall show no evidence of mechanical damage and the change in resistance shall not exceed ±4 percent.

3.13 Load life. When resistors are tested as specified in 4.6.8, the maximum change in resistance shall not exceed 3 percent.

3.14 Salt spray (corrosion). When resistors are tested as specified in 4.6.9, resistors shall show no evidence of marked corrosion. The resistors shall be mechanically operative and electrically continuous through all three terminals, over the total mechanical rotation, and shall show no disturbances of the ground connection to the marking panel.

3.15 Moisture resistance. When resistors are tested as specified in 4.6.10, resistors shall no evidence of mechanical damage, and the maximum change in resistance shall not exceed 10 percent. The insulation resistance shall be not less than 3.5 megohms.

3.16 Resistance to soldering heat. When resistors are tested as specified in 4.6.11, resistors shall show no mechanical damage and the change in resistance shall not exceed 2 percent.

3.17 Rotational life. When resistors are tested as specified in 4.6.12, the permanent change in resistance shall not exceed 5 percent, nor shall proper contact be broken during or as result of the test.

3.18 Switch life. When resistors are tested as specified in 4.6.13, switches shall make, carry, and break, without damage, the specified current. The contact resistance shall not exceed 0.05 ohm.

3.19 Insulation resistance. When resistor are tested as specified in 4.6.14, the insulation resistance shall not be less than 100 megohms.

3.20 Shock (specified pulse). When resistors are tested as specified in 4.6.15, there shall be no open circuit or intermittent contact; movement of the contact arm shall not result in a resistance change greater than 10 percent; the total resistance shall not change in excess of 2 percent; and there shall be no evidence of mechanical damage.

3.21 Vibration, high frequency. When resistors are tested as specified in 4.6.16, there shall be no open circuit or intermittent contact; movement of the contact arm shall not result in a resistance change greater than 10 percent; the total resistance shall not change in excess of 2 percent; and there shall be no evidence of mechanical damage.

3.22 Solderability. When resistors are tested as specified in 4.6.17, resistors shall meet the criteria for tab evaluation in the test method.

3.23 Fungus. All external materials shall be nonnutrient to fungus growth 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 4.6.18. There shall be no evidence of fungus growth on the external surfaces.

3.24 Marking. Resistors shall be permanently marked with the PIN and the manufacturer's name or trade mark. If space permits, the resistance in ohms shall also be marked. The PIN shall be marked on either the rear or the periphery of resistors. There shall be no space between symbols which 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 temperature and moisture-resistance characteristic and shaft designations, as shown in the following example:

RA30NA
SK103A

Marking shall remain legible at the end of all tests.

3.25 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality and shall be free from holes, fissures, chips, corrosion, and malformation. The terminals shall be unbroken and not crushed or nicked, and the resistors shall be free from defects that will affect life, serviceability, or appearance.

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

3.25.2 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 have been used, unless it can be shown that corrosive elements have been satisfactorily removed after brazing.

3.25.3 Riveting. When required, the riveting operation shall be carefully performed to assure that the rivets are tight and satisfactorily headed.

## 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 forth in this 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 section 3 and 5. The inspection set forth in this specification shall be 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 the 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 inspection 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.

4.3.1 Precaution. Adequate precaution shall be taken during inspection to prevent condensation of moisture on resistors, except during the thermal shock, and moisture resistance tests.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3).

4.4.1 Sample size. The number of sample units comprising a sample of resistors to be submitted for qualification inspection shall be as specified in the appendix to this specification. The sample shall be taken from a production run and shall be produced with equipment and procedures normally used in production.

TABLE VII. Qualification inspection.

| Examination or test | Requirement paragraph | Method paragraph | Number of failures allowed 1/ |
|---|---|---|---|
| Group I | | | |
| Visual and mechanical examination 2/ | 3.3 to 3.4.11<br>3.24 to 3.25.3 inclusive | 4.6.1 | 0 |
| Dielectric withstanding voltage | 3.7 | 4.6.2 | |
| DC resistance | 3.8 | 4.6.3 | |
| Torque | 3.9 | 4.6.4 | |
| Group II | | | |
| Low temperature storage | 3.10 | 4.6.5 | |
| Low temperature operation | 3.11 | 4.6.6 | 1 |
| Thermal shock | 3.12 | 4.6.7 | |
| Group III | | | |
| Load life | 3.13 | 4.6.8 | 1 |
| Salt spray (corrosion) | 3.14 | 4.6.9 | |
| Group IV | | | |
| Moisture resistance | 3.15 | 4.6.10 | 1 |
| Group V | | | |
| Resistance to soldering heat | 3.16 | 4.6.11 | |
| Rotational life | 3.17 | 4.6.12 | |
| Switch life 3/ | 3.18 | 4.6.13 | 1 |
| Insulation resistance | 3.19 | 4.6.14 | |
| Group VI | | | |
| Shock (specified pulse) | 3.20 | 4.6.15 | |
| Vibration, high frequency | 3.21 | 4.6.16 | 1 |
| Group VII | | | |
| Solderability | 3.22 | 4.6.17 | 0 |
| Group VIII | | | |
| Fungus | 3.23 | 4.6.18 | 0 |

2

1/ Failure of an individual resistor in one or more tests of a test group shall be charged as a single defective.
2/ Marking shall be considered defective only if it is illegible after completion of any of the required inspection.
3/ Not applicable to locking bushings type resistors.

TABLE VIII. Qualification inspection for locking-bushing-type resistors. 1/

| Examination or test | Requirement paragraph | Method paragraph | Number of failures allowed 2/ |
|---|---|---|---|
| Group I | | | |
| Visual and mechanical examination 3/ | 3.3 to 3.4.11 incl, and 3.20 to 3.21.3 | 4.6.1 | 0 |
| DC resistance | 3.8 | 4.6.3 | |
| Torque | 3.9 | 4.6.4 | |
| Group II | | | |
| Moisture resistance | 3.15 | 4.6.10 | 1 |
| Group III | | | |
| Resistance to soldering heat | 3.16 | 4.6.11 | |
| Rotational life | 3.17 | 4.6.12 | |
| Insulation resistance | 3.19 | 4.6.14 | |

1/ This inspection is applicable only to 12 additional locking-bushing-type resistors when submitted with standard-bushing type.
2/ Failure of an individual resistor in one or more tests of the test group will be charged as a single defective.
3/ Marking will be considered defective only if the marking is illegible after completion of any of the required inspections.

4.4.2 Test routine. Sample units shall be subjected to the qualification inspection specified in table VII or VIII, in the order shown. All sample units shall be subjected to the inspection of group I. The specimens shall then be divided into groups in accordance with table XVI or XVII as applicable, and subjected to the inspection for their particular group. For combined-type submission, the inspection routine shall be in accordance with the appendix to this specification.

4.4.3 Defectives. Defectives in excess of those allowed in table VII or VIII will be cause for refusal to grant qualification.

4.4.4 Retention of qualification. To retain qualification, the supplier shall forward at 1-year intervals to the qualifying activity, a summary of the results of group A and B tests, indicating as a minimum the number of lots that have passed and the number that have failed, and a summary of the results of group C tests, including the number and type of any part failures. The summary of the test shall include those tests performed during that 1 year period. If the summary of the test results indicate nonconformance with specification requirements, action will be taken to remove the failing product from the qualified products list. Failure to submit the summary shall result in the 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 1 year period that the inspection data indicates failure of the qualified product to meet the requirements of the specification.

4.5 Quality conformance.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of the groups A and B inspection.

4.5.1.1 Inspection lot. An inspection lot, as far as practicable, shall consist of all resistors of the same style produced under essentially the same conditions, and offered for inspection at one time. Sealed resistors shall not be included in the same lot with unsealed resistors. A lot may include more than one order.

4.5.1.2 Group A inspection. Group A inspection shall consist of the examination and tests specified in table IX, and shall be made on the same set of sample units, 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 X. 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 X. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification. Resistance values in the samples shall be representative, and where possible, in proportion to the resistors in the inspection lot.

4.5.1.2.1.2 Subgroup 2. A sample of parts from each inspection lot shall be randomly selected in accordance with table X. 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 X. If one or more defects are found in this 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. Thirteen samples shall be selected randomly from each inspection lot and subjected to the subgroup 3 solderability test. If there are one or more defects, the lot shall be considered to have failed.

4.5.1.2.1.3.2 Rejected lots. In the event of one or more defects, the inspection lot is rejected. The manufacturer my 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 4.6.1.7. Production lots that pass the solderability test are available for shipment. Production lots failing the solerability test can be reworked only if submitted to the solder dip procedure in 4.5.1.2.1.3.2b.

b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.4.6.1. Following the solder dip, the electrical measurements required in group A, subgroup 1 tests shall be repeated on the lot. Thirteen additional samples shall then be selected and subjected to the solderability test with zero defects allowed. If the lot fails the solderability test the lot shall 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.

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.

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

4.5.1.3.1 Sampling plan. A sample of parts shall be randomly selected in accordance with table XII. 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 XII. If one or more defects are found in the second sample, the lot shall be not supplied to this specification.

TABLE IX. Group A inspection.

| Examination or test | Requirement paragraph | Method paragraph | Sampling plan |
|---|---|---|---|
| Subgroup 1 | | | |
| Dielectric withstanding voltage (atmospheric pressure) | 3.7 | 4.6.2.1 | See 4.5.1.2.1.1 |
| Total resistance | 3.8.1 | 4.6.3.1 | |
| Subgroup 2 | | | |
| Visual and mechanical examination | 3.3 to 3.4.11 3.24 to 3.25.3 inclusive | 4.6.1 | See 4.5.1.2.1.2 |
| Subgroup 3 | | | |
| Solderability | 3.22 | 4.6.17 | See 4.5.1.2.1.3 |

TABLE X. Group A sampling plan.

| Lot size | Subgroup 1 sampling plan | Subgroup 2 sampling plan |
|---|---|---|
| 1 to 12 | 100 percent | 100 percent |
| 13 to 90 | 100 percent | 13 |
| 91 to 150 | 125 | 13 |
| 151 to 280 | 192 | 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 |

TABLE XI. Group B inspection.

| Examination or test | Requirement paragraph | Method paragraph |
|---|---|---|
| Dielectric withstanding voltage (reduced barometric pressure) | 3.7 | 4.6.2.2 |
| Resistance taper | 3.8.2 | 4.6.3.2 |
| Torque | 3.9 | 4.6.4 |

TABLE XII. Group B sampling plan.

| Lot size | Subgroup 1 sample size | Subgroup 2 sample size |
|---|---|---|
| 1 to 25 | 3 | 5 |
| 26 to 50 | 5 | 5 |
| 51 to 90 | 6 | 5 |
| 91 to 150 | 7 | 5 |
| 151 to 280 | 10 | 5 |
| 281 to 500 | 11 | 5 |
| 501 to 1,200 | 15 | 5 |
| 1,201 to 3,200 | 18 | 5 |
| 3,201 to 10,000 | 22 | 8 |
| 10,001 to 35,000 | 29 | 13 |
| 35,001 and over | 29 | 20 |

TABLE XIII. Group C inspection.

| Examination or test | Requirement paragraph | Method paragraph | Number of samples tested | Number of failures allowed |
|---|---|---|---|---|
| Quarterly | | | | |
| Subgroup 1 | | | | |
| Low temperature storage | 3.10 | 4.6.5 | 6 | 1 |
| Low temperature operation | 3.11 | 4.6.6 | | |
| Thermal shock | 3.12 | 4.6.7 | | |
| Subgroup 2 | | | | |
| Resistance to soldering heat | 3.16 | 4.6.11 | 6 | |
| Rotational life | 3.17 | 4.6.12 | | |
| Switch life 1/ | 3.18 | 4.6.13 | | |
| Insulation resistance | 3.19 | 4.6.14 | | |
| Subgroup 3 | | | | |
| Moisture resistance | 3.15 | 4.6.10 | 10 of the highest value in production | 1 |
| Semiannually | | | | |
| Subgroup 1 | | | | |
| Load life | 3.13 | 4.6.8 | 6 | 1 |
| Salt spray (corrosion) | 3.14 | 4.6.9 | | |
| Subgroup 2 | | | | |
| Shock (specified pulse) | 3.20 | 4.6.15 | 6 | |
| Vibration, high frequency | 3.21 | 4.6.16 | | |

1/ Not applicable to locking-type-bushing resistors.

4.5.1.3.2 Disposition of sample units. Sample units which have passed all the group B inspection may be delivered on the contract or purchase order, if the lot is accepted.

4.5.1.4 Group C inspection. Group C inspection shall consist of the tests specified in table XIII, in the order shown. Separate samples of the size required by table XIII shall be used for each subgroup listed.

4.5.1.4.1 Sampling plan. The number of sample units to be inspected shall be in accordance with table XIII, and shall be of the same style currently in production. These sample units shall have passed all groups A and B tests.

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

4.5.1.4.3 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). Groups A and B 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.

4.5.2 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 examination and test.

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 3.3 to 3.4.6, 3.4.7 to 3.4.11, 3.24 to 3.25.3 inclusive).

4.6.2 Dielectric withstanding voltage (see 3.7).

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

a. Test potential: 900 volts root-mean-square (rms).

b. Potential: From an alternating-current (ac) supply at commercial line frequency and waveform.

c. Points of application of test voltage: Between the terminals tied together and all external metal portions of the resistors and metal mounting plate.

d. Examination and measurements: During the tests, the leakage current shall be measured. At the conclusion of the test, resistors shall be examined for evidence of mechanical damage.

4.6.2.2 Barometric pressure. Resistors shall be tested in accordance with method 105 of MIL-STD-202. A potential of 450 volts rms (or as specified, see 3.1), from an alternating-current at commercial line frequency, and waveform of not more than 100 hertz shall be applied for 1 minute between all terminals connected together and bushing.

4.6.3 DC resistance (see 3.8). Resistors shall be tested in accordance with method 303 of MIL-STD-202. The following details shall apply:

a. Measuring apparatus: Measuring instruments used for initial and final readings of this test, can be of different styles or models provided the performance is equivalent. All test equipment shall be calibrated in accordance with MIL-STD-45662.

b. Measurement energy for electronic test equipment: The measurement energy applied to the unit under test shall not exceed 10 percent of the +25°C rated wattage times 1 second.

c. Test voltage for bridges: Measurements of resistance shall be made by using the test voltage specified in table XIV. 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 when ever a subsequent resistance measurement is made.

TABLE XIV. 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 | 30.0 |

4.6.3.1 Total resistance (see 3.8.1). The total resistance of resistors shall be measured between the terminals of the resistance element with the contact arm against at the low-resistance end of the taper. The resistance value obtained shall be compared with the specified nominal total resistance.

4.6.3.2 Resistance taper (see 3.8.2). Following the measurement of total resistance, a resistance measurement shall be made at 30, 50, 70, and 100 percent of electrical rotation. The percent of measured resistance verse percent of electrical rotation shall be determined from the values obtained as follows:

Taper A (linear)

(From 0 to 100 percent electrical rotation)

$$\text{Percent measured resistance} = \frac{\text{Resistance} \times 100}{\text{Total resistance measured}}$$

Tapers C and F (nonlinear)

(From 0 to 50 percent electrical rotation)

$$\text{Percent measured resistance} = \frac{\text{Resistance} \times 100}{\text{Measured resistance at 50 percent rotation} \times 10}$$

(From 50 to 100 percent electrical rotation)

$$\text{Percent measured resistance} = \frac{\text{Resistance} \times 100}{\text{Total measured resistance}}$$

4.6.3.3 Minimum resistance (see 3.8.3). The contact arm shall be rotated to its extreme counterclockwise limit of mechanical rotation. With the arm in this position, the resistance between the left terminal and the center contact terminal shall be measured. The contact arm shall then be rotated to its extreme clockwise limit of mechanical rotation. With the arm in this position, the resistance between the right terminal and the center contact terminal shall be measured. For resistors with actuated switches, the minimum resistance shall be measured with the switch on the exact point where the shaft actuator makes mechanical contact with the switch actuator when moving so as to begin to turn the switch off. Minimum resistance shall also be measured with the switch at the off position (see 3.8.3).

4.6.4 Torque (see 3.9).

4.6.4.1 Mounting. The resistors shall be mounted by their normal mounting means, and a maximum of 10 inch-pound torque shall be used in tightening the mounting nut.

4.6.4.2 Operating (see 3.9.1). The torque required to rotate the contact arm on the resistance element shall be determined throughout the entire range of mechanical rotation by the torque wrench method or by any other method satisfactory to the qualifying activity.

4.6.4.3 Stop (see 3.9.2). Resistors shall be mounted on a metal panel 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 stops.

4.6.4.4 Locking (see 3.9.3). Resistors shall be mounted on a metal panel by their normal mounting means and set at approximately 40 percent of the resistance value (measured between the counterclockwise end terminal and the center tap). The locking device shall be tightened with a torque not greater than that specified. With the locking device tightened, the operating shaft shall withstand the specified torque (see 3.1). Movement of the shaft shall be checked visually and resistors shall be examined for evidence of damage. The total resistance shall be measured.

4.6.5 Low temperature storage (see 3.10). The total resistance shall be measured at +25°C +10°C, -5°C. Within 1 hour after this measurement, resistors shall be placed in a chamber at a temperature of +25°C +10°C, -5°C. The temperature in this chamber shall be lowered to -63°C +0°C, -2°C within a minimum period of 3 hours. Twenty-four hours after the resistors have reached this temperature, the temperature of the chamber shall be gradually raised to +25°C +10°C, -5°C within a maximum period of 8 hours. Resistors shall then be removed from the chamber and maintained at +25°C +10°C, -0°C for a period of approximately 72 hours, after which the total resistance shall be measured.

4.6.5.1 Quality conformance inspection. At the option of the manufacturer, the sample units may be placed in or removed from the test chamber while the chamber is at the extreme low temperature.

4.6.6 Low temperature operation (see 3.11). The total resistance shall be measured at +25°C +10°C, -5°C. The resistors shall then be placed in a chamber at +25°C +10°C, -5°C and the temperature in the chamber shall be lowered to -55°C +10°C, -5°C with a minimum period of 1 hour 30 minutes. After 1 hour ±15 minutes of stabilization at this low temperature, rated continuous working voltage (see 3.1), shall be applied for 45 minutes across the resistance element between one end terminal and the contact arm, with the contact arm against the opposite stop. The resistors shall then be allowed to stabilize for 1 hour ±15 minutes and the torque necessary to effect rotation of the contact arm shall be measured. Following this measurement, the temperature shall be gradually raised to +25°C +10°C, -5°C within a period of 24 hours. The resistors shall then be removed from the chamber and maintained at +25°C +10°C, -5°C for approximately 24 hours, after which the total resistance shall measured (see 3.1).

4.6.6.1 Quality conformance inspection. At the option of the manufacturer, the extreme low temperature may be -63°C +0°C, -2°C and the sample units may be placed in or removed from the test chamber while the chamber is at the extreme high or low temperature.

4.6.7 Thermal shock (see 3.12). Resistors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter: A.

b. Measurement before cycling: Total resistance shall be measured as specified in 4.6.3.1.

c. Measurements after cycling: Total resistance shall be measured as specified in 4.6.3.1. 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 XIV.

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

4.6.8 Load life (see 3.13).

4.6.8.1 Test conditions. During this test, resistors with a diameter of 2 inches (51 mm) or less shall be mounted with their terminals positioned downward on a 4 inch (102 mm) square, .050 inch (1.27 mm) thick, steel panel in still air. Still air is surrounding air with no circulation other than that created by the heat of the resistor being operated. Shielding shall be located no closer than 12 inches (304 mm) from the panel. This test shall be conducted at a temperature of +40°C ±5°C, whenever possible.

4.6.8.2 Procedure. Following a measurement of resistance within the chamber, at test temperature, rated wattage (see 3.1) shall be applied 1 hour 30 minutes "on" 30 minutes "off" for a total of 1,000 hours through the contact arm and one resistance element terminal, so that rated wattage is dissipated across the entire resistive element. Adequate precaution shall be taken to maintain constant wattage on resistors under test. Resistance measurements shall be made at the end of the 30 minute "off" periods after 100 ±8, 200 ±8, 500 ±12, and 1,000 ±12 hours have elapsed.

4.6.9 Salt spray (corrosion) (see 3.14). Resistors shall be mounted on an aluminum panel (2S), with their terminals positioned downward and tested in accordance with method 101, test condition A (salt solution 5 percent) of MIL-STD-202. At the conclusion of the test, the resistor covers, if any, shall be removed, the resistors shall be thoroughly rinsed in clear tap water, and then be permitted to dry for 24 ±4 hours at +40°C ±2°C. Resistors shall then be examined for evidence of damage and corrosion. The resistors shall be tested for electrical continuity between the end terminals and contact arm terminal and each end terminal over the total mechanical rotation.

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

a. Mounting: On a noncorrosive metal panel with operating shaft in a horizontal position and radial terminals pointed downward.

b. Initial measurements: Resistance shall be measured as specified in 4.6.3 and insulation resistance shall be measured as specified in 4.6.14.

c. Load: During steps 1 and 4, a dc voltage corresponding to 65 percent rated wattage (see 3.1) shall be applied for the first 2 hours of each step to all resistors. The voltage shall be applied across the left terminal and contact arm, with the operating shaft rotated to the maximum clockwise position (see figure 1).

d. Final measurements: At the end of the last cycle and while the resistors are still in the test chamber at the high humidity condition, total resistance shall be measured as specified in b. above. Following this measurement of total resistance and for purposes of performing the insulation resistance and dielectric withstanding voltage tests, the test chamber may be opened in order to make the necessary electrical connections. These tests shall be performed after chamber has been returned to the high humidity condition for at least 1 hour. Insulation resistance shall be measured between all the resistor terminals connected together and the mounting bushing, using a dc potential of 100 volts. Dielectric withstanding voltage shall be tested as specified in 4.6.2.1 except that the test potential applied to the resistors shall be 250 volts. The subsequent 24-hour conditioning period and measurements do not apply.

4.6.11 Resistance to soldering heat (see 3.16). Resistors shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

a. Measurement before test: DC resistance shall be measured as specified in 4.6.3.

b. Test condition letter: A.

c. Depth of immersion in the molten solder: To a point .125 to .1875 inch (3.18 to 4.763 mm) from the resistor body.

d. Examination and measurement after test: Four hours ±30 minutes after completion of test, the dc resistance shall be measured as specified in 4.6.3. Resistors shall be examined for evidence of mechanical damage.

4.6.12 Rotational life (see 3.17).

4.6.12.1 Mounting. During this test, resistors shall be centrally mounted on a 4 inch (102 mm) square, .050 inch (1.27 mm) thick, steel panel, with their terminals positioned downward. Care should be taken to insure that side thrust is minimized by the proper alignment of the resistors shafts with the drive shafts. The resistors shall be ganged in pairs and each pair shall be connected in series as shown on figure 5 so that a nominally constant current flows through the resistors irrespective of the contact arm position during oscillation of the shafts. The shafts shall be so connected mechanically that they will turn simultaneously in the same direction. When performing this test on locking bushing type resistors, the locking nut shall be removed.

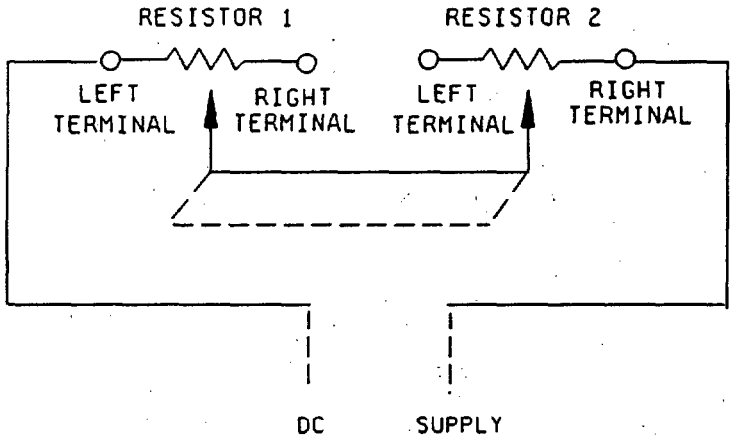



FIGURE 5. Rotational life test circuit.

4.6.12.2 Rotation. A dc potential equivalent to that required to dissipate rated wattage across the entire resistive element of resistors having the same nominal total resistance as those under test, shall then be applied as shown on figure 5. Resistor shafts shall then be continuously oscillated through not less than 98 percent of the total mechanical rotation (see figure 1), at the rate of approximately 10 ±2 cycles per minute for not less than 4,000 cycles per day for a total of 25,000 cycles. Locking bushing types shall be rotated for a total of 500 cycles. The contact arm shall oscillate over the end of the element to which connection is made and proper contact of the contact arm with the winding shall be maintained. Total resistance of resistors shall be ascertained at the end of every 5,000 cycles for all resistors except the locking bushing type. The rotational life test shall be conducted at room ambient temperature.

4.6.12.3 Quality conformance inspection. At the option of the manufacturer, the sample units may be rotated at a rate of 8 to 30 cycles per minute.

4.6.13 Switch life (see 3.18). A current of 3.0 ampere flowing through a carbon lamp or a wire-wound resistor load with an ac rms potential of 117 volts ±10 percent applied, applied at commercial line frequency and waveform of not more than 100 hertz, shall be interrupted 15,000 times by the operation of the switch. Switch contact resistance shall be measured both before and after the 15,000 cycles of on-off operation. At the conclusion of the test, resistors shall be examined for evidence of damage. This test shall be conducted concurrently with the rotational life test specified in 4.6.12.

4.6.14 Insulation resistance (see 3.19). Resistors shall be tested in accordance with method 302 of MIL- STD-202. The following details shall apply:

a. Test condition letter: A.

b. Special preparation: Resistors shall be mounted on metal plates of sufficient size to extend beyond the resistor extremities, and in such a manner that measurements can be made between the terminals tied together and any other external metal parts.

c. Points of measurements: Between the terminals connected together and all external metal portions of the resistors and metal mounting plate.

4.6.15 Shock (specified pulse) (see 3.20). Resistors shall be tested in accordance with method 213 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Resistors shall be mounted by their normal mounting means and affixed on an appropriate mounting fixture. A suggested 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. Test leads used during this test shall be as small a wire size as practicable (e.g., AWG 22 stranded) so the influence of the test lead on the resistor will be held to a minimum. The test lead length shall be no longer than necessary. In all cases, the 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. The contact arm shall be positioned at the approximate midpoint of the resistance element.

b. Measurements after mounting: Total resistance shall be measured as specified in 4.6.3.1; the resistance shall be measured between the contact arm terminal and terminal number one.

c. Test condition: C.

d. Motion: Resistors shall be subjected to a total of 20 impacts (five blows in each of two directions in each of two mutually perpendicular planes). One of the test planes used shall be perpendicular and the other parallel to the longitudinal axis of the operating shaft.

e. Measurement during test: Each resistor shall be monitored to determined momentary discontinuity by a method which shall at least be sensitive enough to monitor or register automatically any momentary discontinuity of 0.1 millisecond or greater duration.

f. Measurements and examination after test: Total resistance shall be measured as specified in 4.6.3.1; the resistance shall also be measured between the contact arm terminal and terminal number one. Resistors shall then be examined for evidence of mechanical damage.

4.6.16 Vibration, high frequency (see 3.21). Resistors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: By normal mounting means and affixed to an appropriate nonresonant mounting fixture. A suggested mounting fixture is shown on figure 6. The mounting fixture shall be constructed in such a manner as to insure that the points of the resistor mounting supports shall have the same motion as the vibration test table. Test leads used during this test shall be as small as practicable (e.g., AWG size 22, stranded) so that the influence of the test lead on the resistor shall be held to a minimum. The test lead lengths shall be no longer than necessary. A shielded cable which may be necessary because of the field surrounding the vibration test table, shall be clamped to the mounting fixture. In all cases, 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 the most detrimental. The contact arm shall be positioned at the approximate midpoint of the resistor element.

b. Measurements after mounting: Total resistance shall be measured as specified in 4.6.3.1; resistance shall also be measured between the contact arm terminal and terminal number one.

c. Test condition: C, part two.

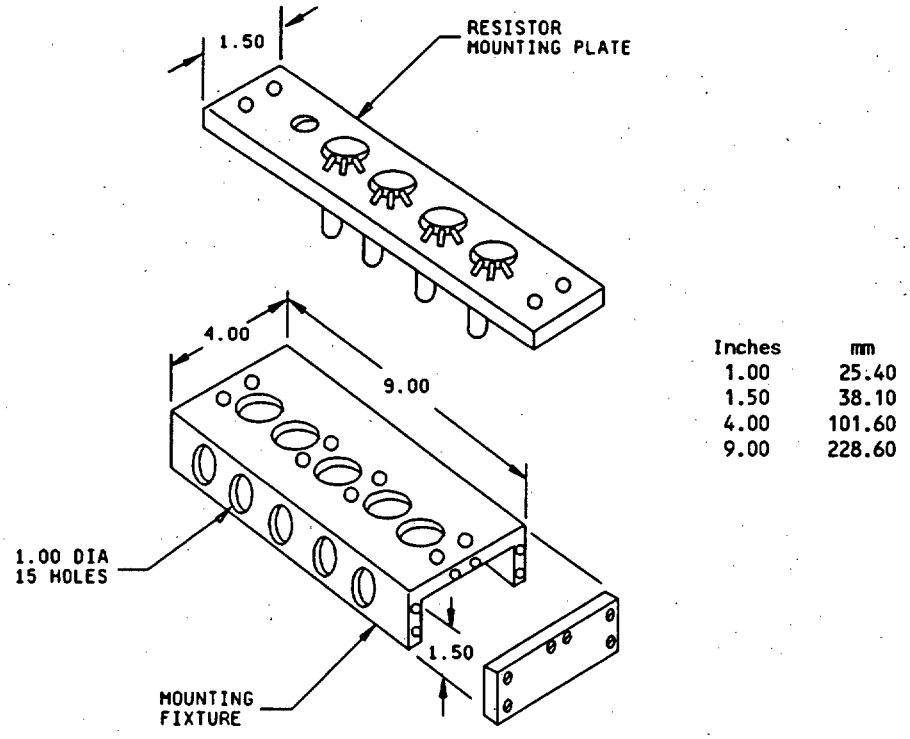



FIGURE 6. Suggested mounting fixture and resistor mounting plate for shock tests.

d. Motion: In each of two mutually perpendicular directions, one perpendicular and the other parallel to the longitudinal axis of the resistor.

e. Measurement during test: Each resistor shall be monitored to determine momentary discontinuity by a method which shall at least be sensitive enough to monitor or register automatically any momentary discontinuity of 0.1 millisecond or greater duration. A measurement of transient resistance change between the contact arm terminal and terminal one shall also be made.

f. Measurements and examinations after test: Total resistance shall be measured as specified in 4.6.3.1; resistance shall also be measured between the contact arm terminal and terminal one. Resistors shall then be examined for evidence of mechanical damage.

4.6.17 Solderability (see 3.22). Resistors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply:

a. All three terminals shall be tested.

b. No special preparation of leads is required.

c. Steam aging shall apply.

d. Terminals shall be dipped within .125 inch (3.18 mm) of body. All three terminals shall be dipped simultaneously whenever possible. When configuration is such that terminals cannot be dipped simultaneously, the .125 inch shall apply to the terminal on whichever it occurs first when all three terminals are dipped in an orientation which most nearly meets the above requirement.

e. Evaluation for tab terminals shall apply.

4.6.18 Fungus (see 3.23). 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. 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 documents. Acquisition documents should specify the following:

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

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

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

d. Mounting hardware (see 3.4.8).

e. Mounting nut dimension across hexagonal flats, as applicable (see 3.1).

f. Location at which inspection shall be made if other than suppliers facilities or commercial laboratory (see 4.1).

6.3 Qualification. With respect to products requiring qualifications, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 19 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 their 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 order for the products covered by this specification. The activity responsible for the Qualified Products List is the US Army Research Laboratory, Electronics and Power Sources Directorate, ATTN: AMSRL-EP-RD, Fort Monmouth, NJ 07703-5302, however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-ELDM), 1507 Wilmington Pike, Dayton, OH 45444-5283 and information pertaining to qualification of products may be obtained from the activity.

6.4 Dissimilar metals. Unless suitably protected, metals such as brass, copper, or steel should not be used in intimate contact with aluminum or aluminum alloys.

6.5 Power rating. The power ratings given on the detail specifications (see 3.1) apply at temperatures up to +40°C, with the resistors mounted on metallic panels thermally equivalent to those specified in 4.6.8.1. Resistors operated at ambient temperatures above +40°C should be derated in accordance with figure 4. Satisfactory operation cannot be assumed at any temperature, if the resistor is not mounted on a metallic panel thermally equivalent to that specified in 4.6.8.1. Such a panel serves as a "heat sink" and dissipates some of the heat generated in such a resistor.

6.6 Nominal maximum current rating. The nominal maximum current rating of resistors is as shown in table XV where W is rated wattage for taper A (linear) resistors and R is the nominal total resistance.

TABLE XV. Maximum permissible current.

| Resistor | High resistance section | Low resistance |
|---|---|---|
| Taper A (linear) | $\sqrt{W/R}$ | |
| Taper C and F (nonlinear, 10 percent) | $0.745\sqrt{W/R}$ | $2.24 \frac{W}{R}$ |

6.6.1 Suggested mounting fixture. A suggested mounting fixture for the shock and high-frequency vibration tests is shown on figure 6.

6.7 Selection and use information. Equipment designers should refer to MIL-STD-199, "Resistors, selection and use of" for a selection of standard resistor types and values for new equipment designs. Application and use information concerning these resistors is also provided in MIL-STD-199.

6.8 Retinning leads. If retinning (hot solder dip) of the leads is required (see 3.4.6.1).

6.9 Subject term (key word) listing.

Potentiometer

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

6.11 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

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 this specification. The information contained herein is intended for compliance.

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

30. SUBMISSION

30.1 Sample.

30.1.1 Single type submission. A sample consisting of 42 specimens of each type for which qualification is sought shall be submitted.

30.1.2 Combined type submission. For qualification of either the standard bushing or the locking bushing type resistors, a sample consisting of the number of sample units specified in table XVI shall be submitted in the highest resistance value for each style and lot coverage for which qualification is sought. To receive qualification of locking bushing type resistors when standard bushing type resistors have been submitted, an additional sample of locking bushing type resistors consisting of the number of specimens specified in table XVII shall be submitted. If resistors are not all of the same basic design, sample resistors of each alternate design shall be submitted.

TABLE XVI. Sample for qualification inspection.

| Lot | Quantity in the same style | Taper | Switch | Inspection group: Specimen numbers (also see table VII) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | I | II | III | IV | V | VI |
| 1 | 30 | A | None | 1 to 30 | 1 to 6 | 7 to 12 | 13 to 18 | 19 to 24 | 25 to 30 |
| 2 | 30 | C | None | 1 to 30 | 1 to 6 | 7 to 12 | 13 to 18 | 19 to 24 | 25 to 30 |
| 3 1/ | 30 | A | None | 1 to 30 | 1 to 6 | 7 to 12 | 13 to 18 | 19 to 24 | 25 to 30 |
| | 30 | C | None | 1 to 30 | 1 to 6 | 7 to 12 | 13 to 17 | 19 to 24 | 25 to 30 |
| 4 | 18 | A | None | 1 to 18 | 1 to 4 | 5 to 8 | 9 to 12 | 13 to 15 | 16 to 18 |
| | 15 | A | SPST | 1 to 15 | 1 and 2 | 3 and 4 | 5 and 6 | 7 to 12 | 13 to 15 |
| 5 | 18 | C | None | 1 to 18 | 1 to 4 | 5 to 8 | 9 to 12 | 13 to 15 | 16 to 18 |
| | 15 | C | SPST | 1 to 15 | 1 and 2 | 3 and 4 | 5 and 6 | 7 to 12 | 13 to 15 |
| 6 1/ | 18 | A | None | 1 to 18 | 1 to 4 | 5 to 8 | 9 to 12 | 13 to 15 | 16 to 18 |
| | 15 | A | SPST | 1 to 15 | 1 and 2 | 3 and 4 | 5 and 6 | 5 and 6 | 13 to 15 |
| 3333 | 30 | C | None | 1 to 30 | 1 to 6 | 7 to 12 | 13 to 18 | 19 to 24 | 25 to 30 |

1/ For lots 3 and 6, number of allowable defectives shown in the last column of table VI will apply individually to the submission that is made in each resistance taper. For all other lots, the number of allowable defectives will be as shown in table VI.

APPENDIX

TABLE XVII. Samples for qualification inspection of additional locking bushing types.

| Quantity in the same style | Test group: Specimen numbers | | |
|---|---|---|---|
| | I | II | III |
| 12 | 1 to 12 | 1 to 6 | 7 to 12 |

30.2 Test data. Each submission shall be accompanied by test data covering the nondestructive tests listed in table VII or VIII which have been performed on the submitted sample units. The performance of the destructive tests by the supplier on a duplicate set of sample units is encouraged, although is not required. All test data shall be submitted in duplicate.

30.3 Certificate of material. When submitting sample for qualification, the manufacturer shall submit certification, in duplicate that the materials used in his components are in accordance with the applicable specification requirements.

30.4 Description of items. The manufacturer shall submit a detailed description of the resistors being submitted for test, including a description of case material, wire type and size, bushing, shaft, terminal, and mounting hardware.

40. EXTENT OF QUALIFICATION

40.1 Single type submission. Qualification as shown in the type submitted.

40.2 Combined type submission. Qualification within a style and characteristic shall be shown in table XVIII. Qualification of resistors with standard (N) type bushings shall qualify resistors with sealed (S) type bushings. Conversely, qualification of resistors with sealed (S) type bushing shall qualify resistors with standard (N) type bushing. Qualification of resistors with locking (L) type bushing shall qualify resistors with sealed (T) type bushings. Conversely, qualification resistors with sealed (T) type bushings shall qualify resistors with locking (L) type bushings.

TABLE XVIII. Extent of qualification.

| Lot | Qualification coverage |
|---|---|
| 1 | All resistance values between the highest and all lower value and all lower values for which qualification is sought; taper A, without switches. |
| 2 | All resistance values between the highest value and all lower values for which qualification is sought; taper C, without switches. |
| 3 | All resistance values between the highest values and all lower values for which qualification is sought; all tapers, without switches. |
| 4 | All resistance values between the highest value and all lower values for which qualification is sought; taper A, with or without switches. |
| 5 1/ | All resistance values between the highest value and all lower values for which qualification is sought; taper C, with or without switches. |
| 6 1/ | All resistance values between the highest value and all lower values for which qualification is sought; all tapers, with or without switches. |

1/ In the event of switch failure only, qualification will be granted as stated, except for switches.

## CONCLUDING MATERIAL

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

Review activities:
Army - AR, AT, AV, ME, MI
Navy - AS, CG, MC, OS
Air Force - 17, 19
DLA - ES

Preparing activity:
Army - ER

Agent:
DLA - ES

(Project 5905-1257)

# 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 MIL-R-19C | 2. DOCUMENT DATE (YYMMDD) 9 November 1994 |
|---|---|---|

3. DOCUMENT TITLE

RESISTOR, VARIABLE, WIRE-WOUND (LOW OPERATING TEMPERATURE), GENERAL SPECIFICATION FOR

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)<br>(1) Commercial<br>(2) AUTOVON (If applicable) | 7. DATE SUBMITTED (YYMMDD) |

8. PREPARING ACTIVITY

| a. NAME<br>U.S. Army Research Laboratory<br>Electronics and Power Sources Directorate<br>ATTN: AMSRL-EP-RD | b. TELEPHONE (Include Area Code)<br>(1) Commercial 908-544-3441<br>(2) AUTOVON |
|---|---|
| c. ADDRESS (Include Zip Code)<br>Fort Monmouth, NJ 07703-5302 | IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:<br>Defense Quality and Standardization Office<br>5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466<br>Telephone (703) 756-2340 AUTOVON 289-2340 |